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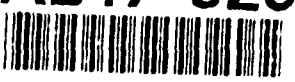

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This paper presents an expert system capable of providing a divisional communications controller a troubleshooting aid to assist in locating and solving military communications problems. Often an inexperienced controller will be faced with an unfamiliar situation and could use the help provided by this artificial intelligence system. The software was developed using Turbo PROLOG as a rule based system with an extensive set of production rules emulating the way an experienced military controller would think through a problem. A user is asked a series of questions and based on the responses provided a probable problem is identified along with a solution to that problem. The program is an off line aid titled "Military Communications Troubleshooting Aid" (MCTA). The use of this program in the Systems Control Element of a Division Signal Battalion would be very beneficial.

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AN EXPERT SYSTEM FOR TACTICAL MILITARY COMMUNICATIONS TROUBLESHOOTING

by

Major Douglas L. Machamer

A thesis submitted in partial fulfillment
of the requirements for the degree of

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Abstract

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By Major Douglas L. Machamer

Chairperson of the Supervisory Committee:

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Department of Electrical Engineering

This paper presents an expert system capable of providing a divisional communications controller a troubleshooting aid to assist in locating and solving military communications problems. Often an inexperienced controller will be faced with an unfamiliar situation and could use the help provided by this artificial intelligence system. The software was developed using Turbo PROLOG as a rule-based system with an extensive set of production rules emulating the way an experienced military controller would think through a problem. A user is asked a series of questions and based on the responses provided a probable problem is identified along with the solution to that problem. The program is an off line aid titled "Military Communications Troubleshooting Aid" (MCTA). The use of this program in the Systems Control Element of a Division Signal Battalion would be very benificial.

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CHAPTER 1 Introduction

1.1 Background Information

The United States Army is made up of Divisions that have extensive communications requirements using some very complicated equipment. Each Division has a Signal Battalion which provides tactical multichannel communications links between major units within the Division. These 12 channel systems can have a wide variety of command and control circuits and common user switchboard circuits multiplexed on a carrier signal in the very high frequency(VHF) range. The Signal Battalion uses a Communications Systems Control Element (CSCE or SYSCON) to control all of these multichannel and switching assets within the Division. The personnel within this element are primarily senior sergeants and officers who have the expertise to control the systems and solve problems with the network should it arise. Often, an inexperienced controller will be faced with an unfamiliar situation and could use the help of an expert in providing multichannel and switching communications. The expert system discussed in this thesis addresses this need to provide a means of understanding the communications problem and what actions to take to solve the problem.

1.2 Explanation of Expert Systems

An expert system is a practical application of artificial intelligence technology. A knowledge engineer

researches into a particular problem area by interviewing some recognized "experts" in the chosen field. The methods of problem resolution are developed into rules and the expert system is developed to emulate how the "expert" would solve a particular problem given a certain set of circumstances. In this case, the author was the knowledge engineer and could also be considered as one of the "experts" in the field of military communications troubleshooting in addition to the personnel interviewed at Fort Gordon, Georgia. A rule based expert system was chosen to provide the structural basis of the program because the knowledge derived from the "experts" was generally a compilation of troubleshooting rules.

A rule based expert system is structured into three general areas: a knowledge base, an inference engine, and a user interface system. The knowledge base contains the rules describing relations, methods, or knowledge for solving problems. The inference engine consists of the operating rules and priorities that decide how the rules in the knowledge base are applied. It runs the expert system, executes the rules and determines when a solution has been reached. It contains the problem solving approach for the program. The user interface system accepts information from the user and communicates information to the user. It contains all of the written instructions, questions and responses shown on the monitor when the program is run.

1.3 Previous Research in Related Areas

There has been considerable research into expert systems to provide solutions to complex control problems where knowledge can be represented in a computer program. The University of Washington has conducted several research projects into expert systems primarily centering in solving problems related to power systems [3,4,9,10,13]. Most of these expert systems are on line operational aids with some specific purpose. Research has gone on around the world in developing expert systems for a variety of areas including applications to power systems [1,2]. Several researchers have developed expert systems to accomplish diagnostic tasks on systems or equipment [8,12]. Bonneville Power Administration has developed an expert system to monitor their microwave communications system for problems and notify the operator of actions to take in the event of a problem [5,6]. The U.S. Army Signal School has developed an expert system called "SIGAIM" which forms the basis for the research in this thesis [7]. "SIGAIM" is a general shell with all possible signal equipment listed but hardly any information on specific problems or what to do about them. This thesis expands information about equipment contained within a Division Signal Battalion and is complete enough for a controller to use.

1.4 Explanation of Turbo PROLOG

Each Signal Battalion will have at its disposal a computer capable of running the DOS based Turbo PROLOG program. Turbo PROLOG's small cost and ease of use make it ideal for this project. PROLOG stands for "PROgramming in LOGic" which means that the language can be used to emulate human logical thought processes. PROLOG is a declarative goal-driven language unlike procedural languages like C or FORTRAN which specify the steps to solve a problem. Using PROLOG, a programmer declares the logical method for achieving the goal of the program and then internal unification routines search for solutions to satisfy the goal. PROLOG uses predicate logic to deal with the relations between statements and objects. PROLOG attempts to match the program goal with the facts and rules within the program. It offers a solution when conditions are matched or concludes the program when it can't come to a conclusion.

All PROLOG programs are structured into five basic categories of statements. The first being a "database" which contains the types of information being stored for recall during the decision making process. A second area called "domains" is used to declare all non-standard predicate types to ease in later programming. This category is optional and was not used in the development of this expert system. The third category designated "predicates"

declares all the clause forms so the system will know what it will be dealing with. Any clause type not declared in the predicate section will cause an error during compilation of the program. The fourth category is the "goal". It is usually just the designation for the main clause which contains the basic program instructions. The goal does not have to be specified in the program. Upon execution, the program will prompt the user for the goal. To eliminate confusion the goal in this expert system was specified in the program. The fifth category is the "clauses" which is the main body of the program. It contains all the program instructions, facts, rules, and unification routines.

CHAPTER 2 Communication Diagnosis Problem

2.1 Problem Identification

The problem this research deals with is one of how to provide useful information on military communications troubleshooting to an inexperienced controller who must make decisions on what to do with a problem based on information received. The communication diagnosis problem can be very difficult to deal with because often similar symptoms will lead to entirely different problems. The experienced controller can sort out similar symptoms and ask the correct questions to determine what the real problem is. This expert system seeks to sort out a particular problem by asking specific questions in a logical order to determine what the probable problem is with the communications system.

2.2 Communications System Description

A typical communications system block diagram is shown in figure 1 on page 9. This system consists of three major systems; the multichannel terminal, the patch panel and a switchboard with subscriber equipment attached. This divisional multichannel communications site begins at the multichannel antennas where the incoming signal is received and the outgoing signal is transmitted. The multichannel system itself has four major component areas consisting of the radio, multiplexing equipment, cryptographic equipment, and wiring. Within the radio, the orderwire (RT-773) allows

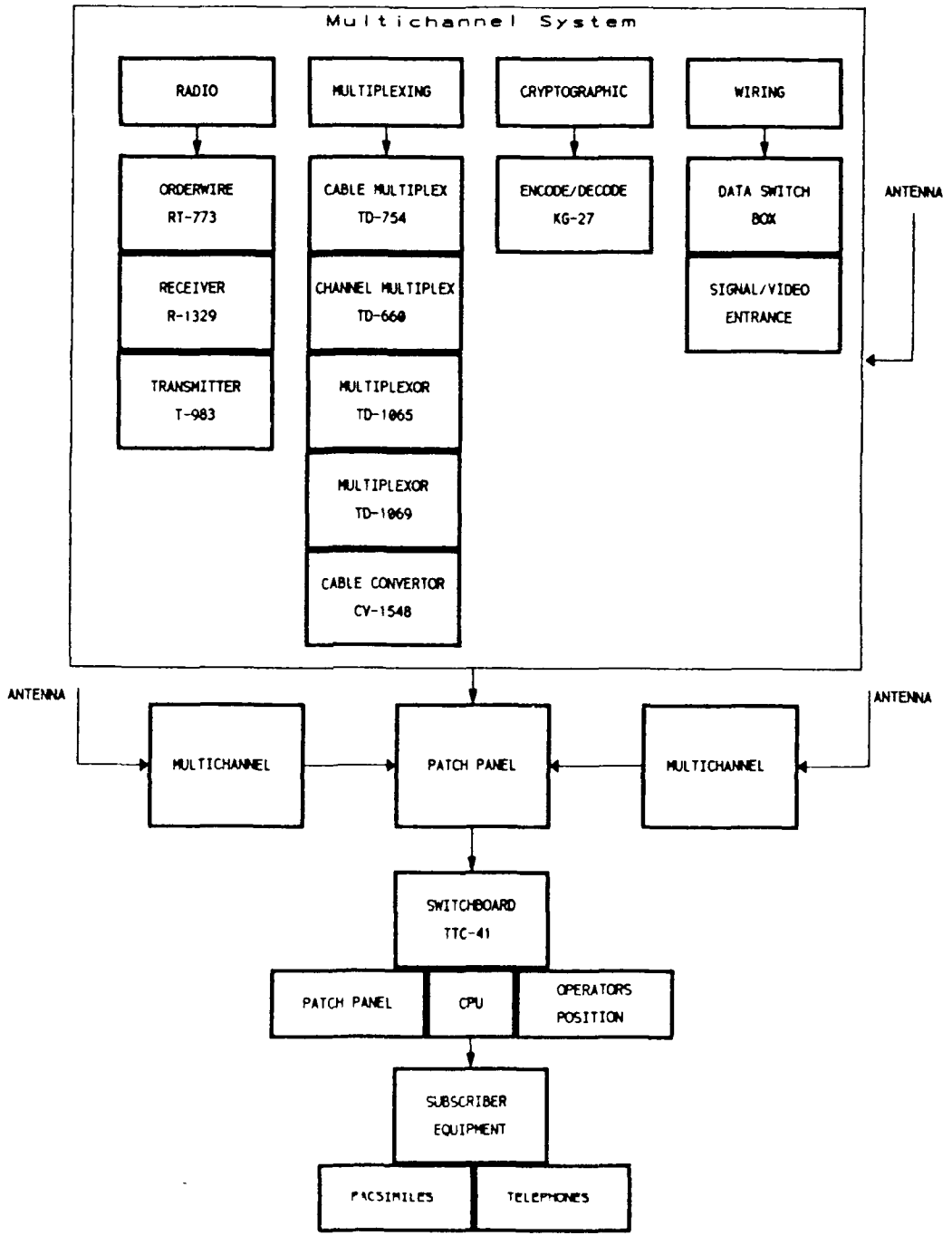
the operator to talk on the carrier frequency to the distant operator without using one of the 12 channels designated for customers. This system facilitates coordination between the operators. The receiver (R-1329) receives the carrier frequency from the incoming signal and passes it to the multiplexors. The transmitter (T-983) transmits out the digital pulse code modulated (PCM) time division multiplexed (TDM) channels on a carrier frequency. The multiplexing equipment begins with a cable multiplexor (TD-754) which allows the TDM channels to be sent on coaxial cable to a distant site versus using the radio equipment. The channel multiplexor (TD-660) takes the PCM signals it receives and multiplexes them into a single bit stream using TDM for transmission by the radio or cable multiplexor. The multiplexors (TD-1065 and TD-1069) do the PCM conversion and make several system assignments. The cable convertor (CV-1548) converts a 1600 Hz tone into a 20 Hz tone for ringing purposes on a single user phone.

The cryptographic equipment consists of a KG-27 with keycards which encodes the bit stream prior to transmission and decodes the bit stream after reception. The wiring consists of all the internal system wiring, the data switch box and the video interconnection and binding post boxes. It is through these cable connections that the 26 pair cable and twisted pair wire connect the multichannel system to the patch panel or switchboard and the users. The patch panel

consists of many rows of interconnect points that an operator can interconnect specific circuits between the switchboard and the multichannel systems connected to it. The switchboard (TTC-41) has a patch panel bay to make circuit interconnections, a central processing unit for database storage and call processing and an operator's position. The switchboard is connected to the subscribers equipment over cable and wire which usually is made up of telephones and facsimile machines.

FIGURE 1

Communications System Block Diagram



2.3 Communications Systems Problems

The problems that can be encountered on a typical military communications system are varied and the expert system described in this thesis covers most of the commonly encountered ones. The problems can be grouped into three general areas which are: those involving an entire site, those involving one multichannel system, or ones pertaining to specific circuits on a system. The problems described within these paragraphs are keyed to the codewords in brackets contained on figures 2 and 3 on pages 16-17.

The site problems affect all communications systems on a site and are generally wide ranging within three major areas. The site may be situated in a valley such that the multichannel systems can not obtain line-of-sight from their antenna to any distant antenna. This problem is one in which a line-of-sight profile needs to be conducted to move the sight to higher ground so communications will be possible. [PROFILE] The entire site may be operating on a central power source such as commercial power or a 60KW generator. If this power source fails, the site will be down until backup power can be started up. [POWER] If a nuclear explosion occurs nearby, an electromagnetic pulse will be emitted which destroys the electronic circuitry within the multichannel and switchboard systems. [EMP]

System problems can be grouped under several general problems and multichannel problems. The general problems

are similar to the site problems but only pertain to one multichannel system. If one multichannel system has a power outage on either end the system will be down until the power is restored. [POWER] There may exist an obstacle such as a mountain between two sites that would necessitate a profile to determine which site needs to move. [PROFILE] A 26 pair or coaxial cable may be damaged or disconnected on a site. [CABLE] The multichannel system may be experiencing radio frequency interference from other systems or outside sources which prevent the system from working. [RFI] The patch panel may have all the circuits improperly patched between systems or may have disconnected cables. [PATCH]

The multichannel system problems can be grouped into five major areas. First, the antenna system may be bad, improperly oriented, have the wrong polarization or be at the wrong height. [ANTENNA] Second, are problems associated with the radio system dealing with the orderwire, receiver and transmitter. The orderwire can have problems with its power indicator [PWR IND], the tone pack used for signalling the distant operator [TONE], or the operator can not get the distant operator to answer [CONTACT]. The receiver can have problems with its power indicator [PWR IND], its voltmeter [VOLT], its signal indicator [SIG IND] or its 12 channel pulse code modulator (PCM) indicator [12/PCM]. The transmitter can have similar problems with its power indicator [PWR IND], voltage readings [VOLT], power/signal

readings [PWR/SIG] or its 12 channel PCM indicator [12/PCM].

Third, are problems dealing with the multiplexing equipment. The TD-754 multiplexor can have problems with its power indicator [PWR IND], voltage readings [VOLT], mileage settings for how long a cable system is [MILEAGE], alphabet switch settings which are separate meter readings [ALPHA], or PCM/timing settings. [PCM/TIM] The TD-660 multiplexor can also have power problems [PWR IND], voltage readings [VOLT], alphabet switch settings [ALPHA], noise generator [NOISE], oscillator [OSC] or PCM/timing [PCM/TIM]. The CV-1548 convertor can have problems with its power indicator [PWR IND], the 20 Hz drive module [20 HZ DR] or its ringer cards [RNG CRD]. The TD-1065 multiplexor can have problems with its power [PWR IND], voltage readings [VOLT], transmitter and receiver positions [XTM/REC], or its communications channel settings [COMCHAN]. The TD-1069 multiplexor could have power indicator problems [PWR IND], DC out indications [DC OUT], rate/function switch readings [RATE/FN], port settings [PORT] or assignment setting problems [ASSIGN].

Fourth, the multichannel system could be experiencing some problems with its cryptographic equipment. The KG-27 may not be getting proper power [PWR IND] or the key card may be improperly set or set using the wrong keylist [KEYLIST]. Fifth, the system may be having some sort of wiring problems. The data switch box may have a system

switch problem [SYS SW] or an audio switch problem [AUDIO]. The video interconnect and binding post box may have improper connections [CONNECT] or have wires hooked to the wrong channel [CHAN].

Circuit problems can be grouped into four areas dealing with cabling, the patch panel, the multichannel system or the switchboard. These problems only affect certain circuits on a system. There could be bad cable pairs somewhere on the site [CABLE] or the patch panel may have a bad patch cord or be improperly interconnected [PATCH]. The multichannel system may have minor wiring problems [WIRING] or multiplexing problems. The TD-660 multiplexor may have improper switch settings [SW SET], channel cards may be misaligned [ALIGN] or cards may be bad [CARD]. The TTC-41 switchboard could have problems with its database [DATABS], the central processing unit [CPU], how the circuits are connected [PATCH] or have problems with the connected subscriber equipment [SUB EQ].

2.4 Problem Resolution With An Expert System

An expert systems approach to solving this particular communications diagnosis problem fits well in relation to the factors of suitability, feasibility, and technical approach. This troubleshooting problem is very suitable for an expert system because its solution can be naturally formed into a set of rules specifying how an expert would

think their way through the problem. The development of this expert system using Turbo PROLOG for use on a Personal Computer is very feasible because the software is inexpensive and there are existing machines to run the executable program once it is developed. The technical approach to military communications troubleshooting was gained through years of experience with military units in the field. The knowledge gained from the Signal School at Fort Gordon provided the technical basis for forming the knowledge base. Due to the nature of the knowledge base, the rules could be structured such that the "experts" method of arriving at a solution was emulated by the program.

2.5 MCTA Problem/Question Structure

The Military Communications Troubleshooting Aid is structured around a set of production rules which ask questions in a certain logical order and based on the responses provided by the user it tells the user what the problem is and what to do about it. The MCTA program rules are grouped by the type of problem encountered and the order in which questions are asked is determined by the structure discussed below. The MCTA problem/question structure is depicted in figures 2 and 3 on pages 16-17. The numbers contained next to the blocks are keyed to the question list contained in Appendix B (See page 99) which are the order in which questions are asked in the program. Boxes on the

diagram represent major areas of questioning and the ovals with problem codewords inside are the individual problems with the associated question. As a user traverses the decision tree a "yes" answer to a specific question will give a positive response to the database making the area or problem next to the question number true. If a "no" answer is given then that means the question is not true and the program continues to the next node in the tree and asks the next question. Once at a node in the tree next to an oval problem, if a positive response is given then the problem associated with the question will have met all the conditions under its "prob_is" clause. At that point the "prob_is" clause will print out its probable problem and initiate the actions to solve the problem under the "resp" clause associated with the problem. The problems contained under the area of multichannel are more complex and so a continuation page is shown in figure 3. Once question number 12 is reached, figure 3 is used until all the system problems dealing with multichannel systems are completed at question number 67. Figure 2 picks up again with question number 68 at the top of the circuit problems and continues down to number 85 where it jumps back up to the top for the site installation guide section.

FIGURE 2

Problem/Question Structure For MCTA Program

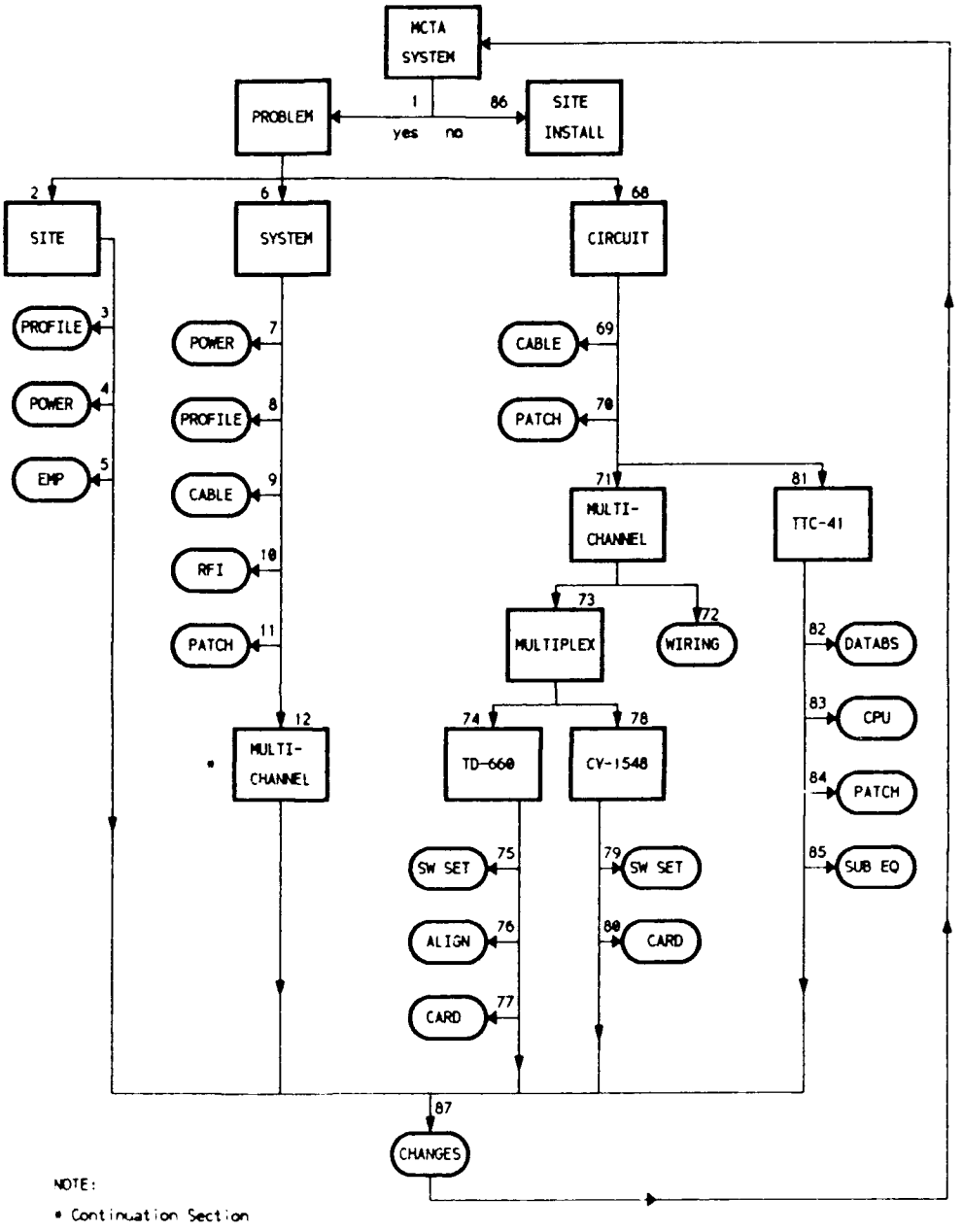
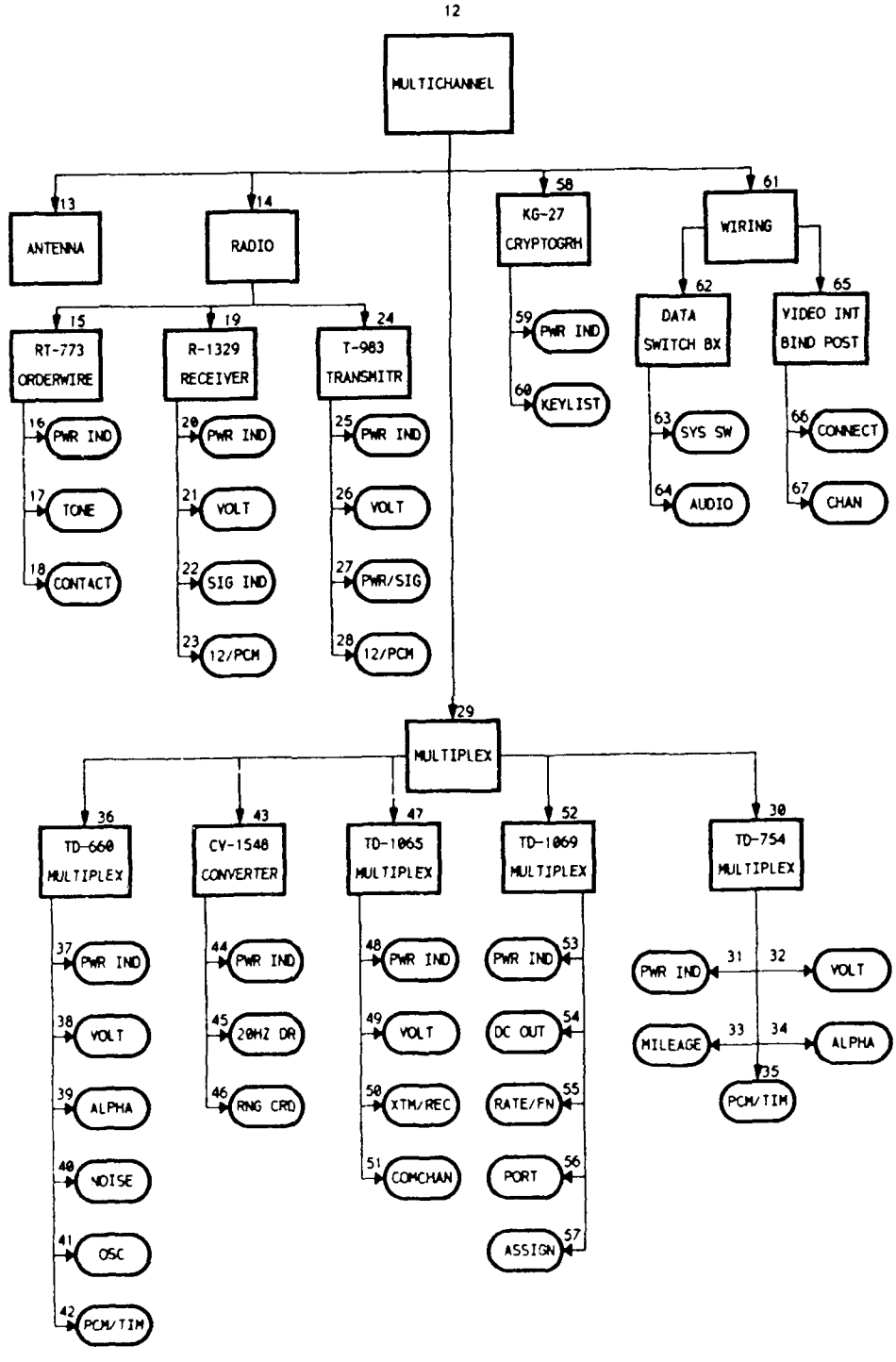


FIGURE 3

Problem/Question Structure For Multichannel



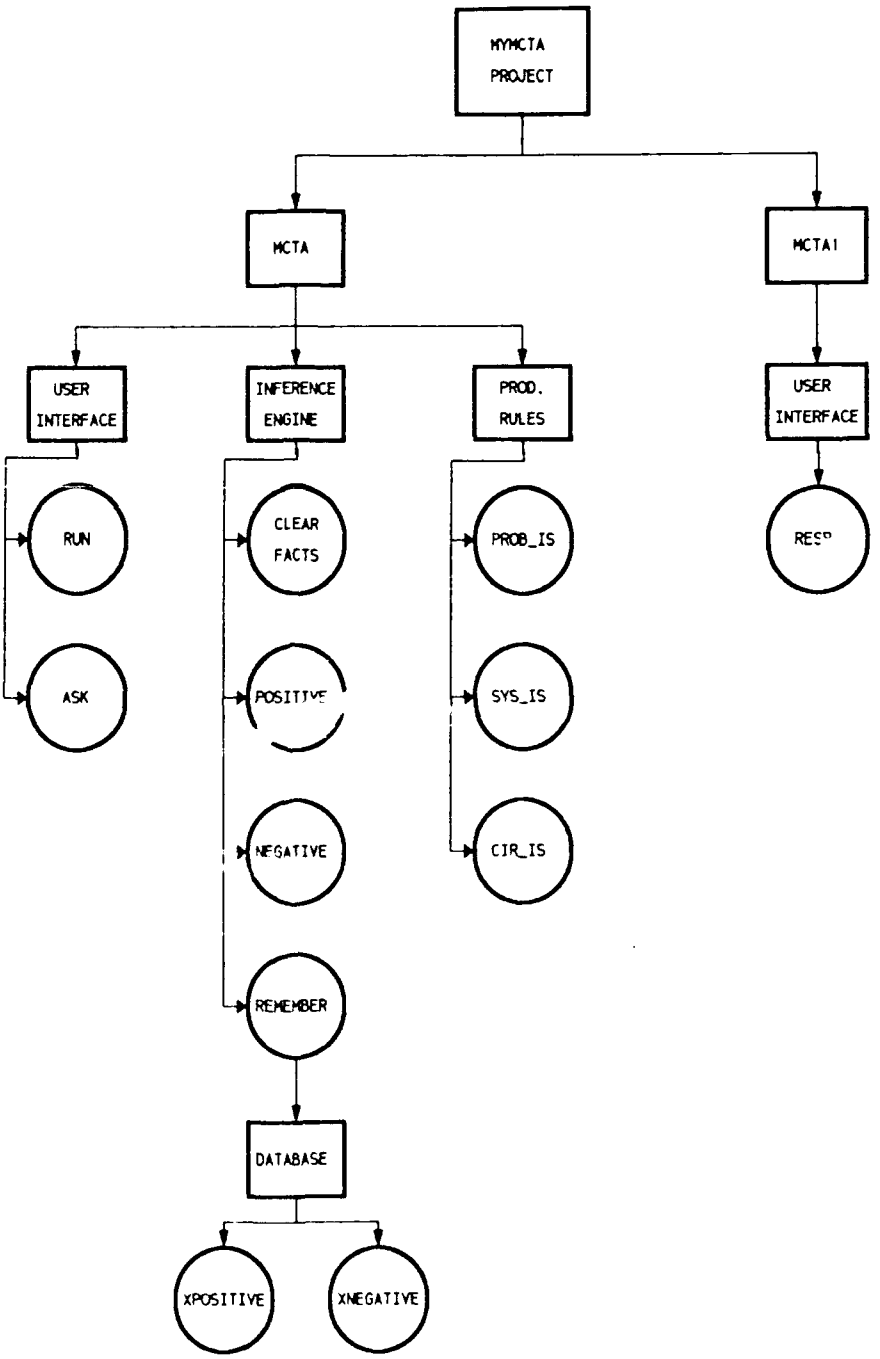
CHAPTER 3 MCTA Software Design

3.1 Program Contents

The expert system to accomplish the communications troubleshooting described in chapter 1 is an off line program entitled "Military Communications Troubleshooting Aid" (MCTA). It is designed to assist controllers in the Systems Control Element of a Divisional Signal Battalion in the identification of problems and actions to solve the problems. It is a rule-based expert system using a set of production rules for the purpose of inferring. The program asks questions in a certain logical order and the user gives yes or no answers. Based on the answers to the series of questions, the system tells the user what the probable problem is with the communications system and what actions to take to solve the problem. The program is contained within a project designated "MYMCTA" and has two modules called "MCTA" and "MCTA1". Figure 4 on the next page shows an organizational chart for the program contents. The MCTA module contains the main program instructions and the user interface system which provides the welcome statements under the "run" clause and asks questions under the "ask" clause. It also contains the entire inference engine and all of the production rules. The MCTA1 module contains the user interface system which provides the actions to take to solve a particular problem under the "resp" clause.

FIGURE 4

Program Contents For MC1A



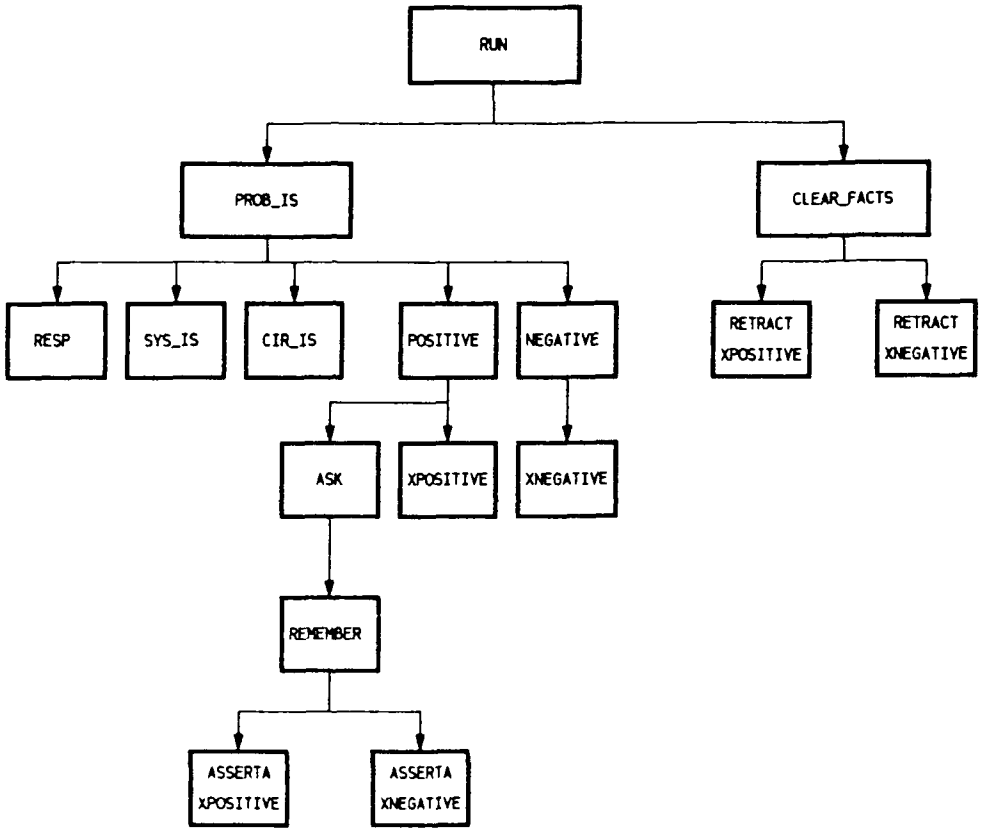
3.2 Structure

The MCTA program is structured in a hierarchical design with the program elements as shown in figure 5 on the next page. The main program clause is "run". It contains some introductory instructions to a user and the main two clauses "prob_is" and "clear_facts". Clear facts comes at the end of the "run" clause and it serves to clear the database of all answers to previous questions so it will be ready for the next round of questioning. It also gives exiting instructions to the user once the program has been completed. The "prob_is" clauses contain all the rules that the goal seeks to satisfy. All other clauses have some interaction with this clause group. The "resp" clause section contains all the actions to solve a particular problem. The "sys_is" and "cir_is" clauses contain definition rules which make programming simpler because it reduces repetitious code lines. The "positive" and "negative" clauses are a part of the inference engine. The rules are organized with "positive" symbols which are codewords associated with certain questions contained under the "ask" clause section. The "xpositive" clause initiates the database to store the answers to the questions. Once the answer to the question is given by the user the yes or no answer is stored in the database using the "remember" clause. If the answer is yes "asserta xpositive" is activated and if the answer is no then the "asserta

xnegative" is used. These values are used as the program seeks to make a decision as to which "prob_is" clause is found to be true.

FIGURE 5

Structure Chart For MCTA



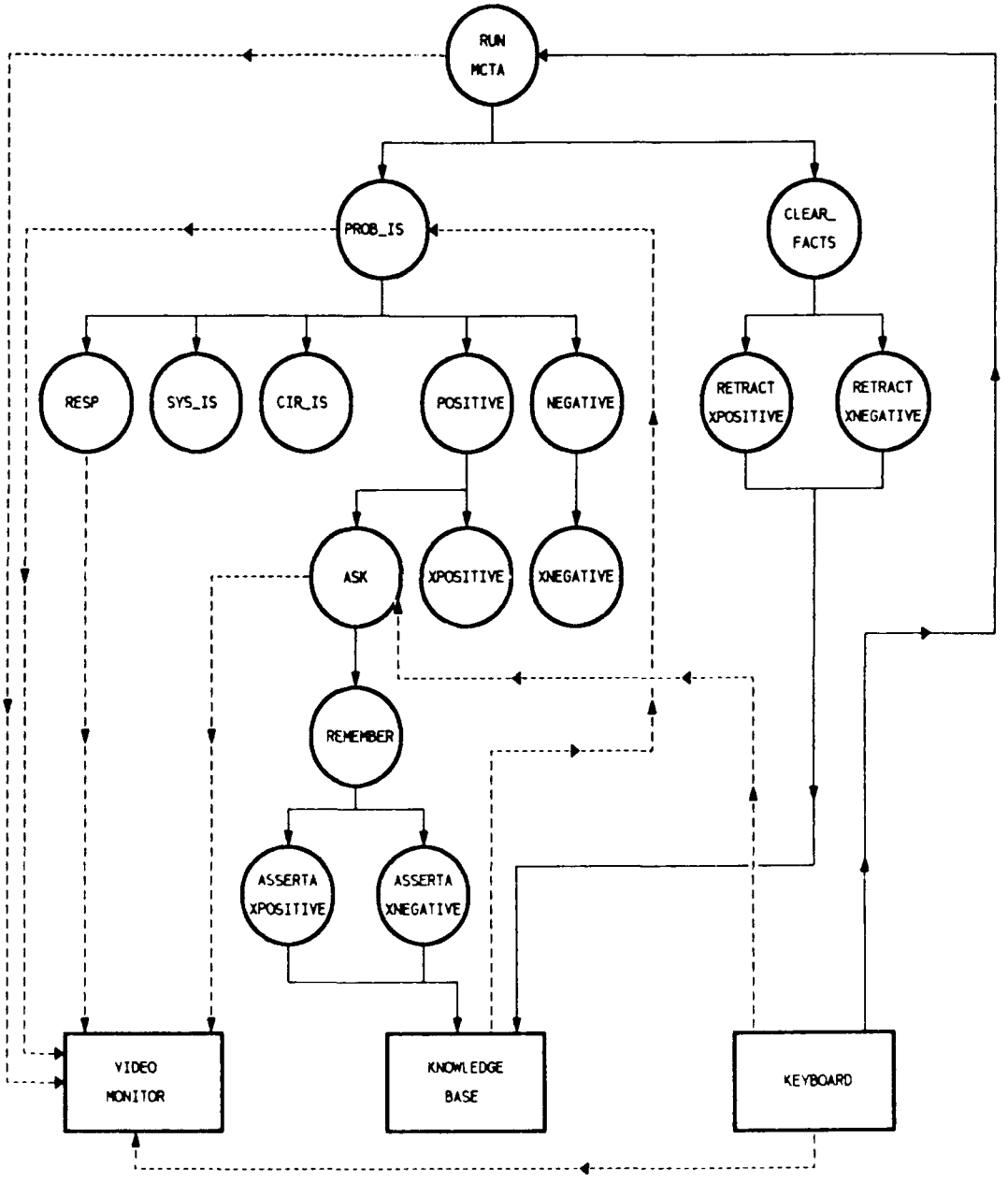
3.3 Data Flow

The MCTA program has the data flow depicted in figure 6 on the next page. Data flow between different parts of the program and the monitor or keyboard is shown as a dashed line. Control flow of the program between the different sections is represented by solid lines. The main clause is "run" and it receives control from the keyboard and maintains control over "prob_is" and "clear_facts" while sending data to the monitor. The "clear_facts" clause receives control from "run" and maintains control over "retract xpositive and xnegative" which will clear the database. The main control clause is "prob_is" which receives data from the knowledge base on how to solve problems and gives data to the monitor. It maintains control over the other program clauses "resp", "sys_is", "cir_is", "positive", and "negative". The "resp" clause contains all the actions to solve problems and it feeds this data to the monitor. The "negative" clause has control over the "xnegative" clause which activates the database. In a similar manner the "positive" clause has control over "xpositive" and "ask" which contains all the questions the program asks. These questions are sent as data to the monitor and it receives input back from the keyboard as the user answers the question. The "ask" clause controls the "remember" clause which controls how the answers are stored in the database under "asserta xpositive and xnegative".

These clauses in turn control the knowledge base which feeds back into the main control clause "prob_is".

FIGURE 6

Data Flow Diagram For MCTA Program



CHAPTER 4 Program Output Flow Examples

4.1 Line of Sight Profile Problem

To demonstrate how the program works it would be most helpful at this point to give some examples of the programs output. A typical site problem output can be illustrated with the line of sight profile problem found in Appendix C (See page 106). The session begins with the welcome statement and then tells the user to answer some questions to determine what the problem is. It also tells the user a site installation guide can be obtained and that intentional pauses are inserted for readability. These instructions are contained within the main clause.

```
Welcome to Military Communications Troubleshooting
Aid(MCTA)

Answer the following questions to determine a probable
cause and response for your multichannel communications
problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation
guide by indicating you do not have a problem and want
the guide.

Intentional pauses have been inserted in the program
for screen readability.  To continue press any key.
```

At the end of the main clause the "prob_is" statement is encountered. The program jumps down to the "prob_is" section and goes through the rules within the if clause. The first predicate it comes to is "positive(problem)" which initiates the inference engine under the positive predicate. The positive predicate then searches through the "ask"

predicate for the "problem" question and then asks it. The user gives a "yes" response and the "remember" predicate within the inference engine stores the yes answer with the problem codeword in the database "xpositive". All subsequent predicates within the rule are checked in this manner until the rule is satisfied. The first question asks if there is a problem and a yes answer keys the second question. The program asks if the problem affects all the systems on a site and a yes answer brings the decision tree down to the third question.

> Do you have a problem you need assistance with somewhere in the Division communications system?
> yes
> Does the problem affect all the multichannel communications systems on a site?
> yes

The user is asked if it is still impossible to receive good communications with other sites and a yes answer completes the diagnosis questions. The program then asks if you would like to make changes and a no answer satisfies the rule.

> Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
> yes
> Would you like to make any changes to the answers provided above by starting over and making the correct entry?
> no

Since the rule was true then it prints out the probable problem may be a line of sight profile.

> Your problem may be a line of sight profile.

Actions to solve the line of sight problem are then displayed by initiating the "resp" predicate contained in the second module.

Actions to Solve Line of Sight Problem

1. Conduct a map reconnaissance to locate a higher site that all multichannel systems can reach.
2. Contact higher level signal planning element for assistance in conducting computer assisted profiling.
3. Relocate communications site to new location and establish communications with all locations.

It talks about conducting a map reconnaissance to locate a higher site. It then tells the user to ask for higher level planning help in doing a computer profile. Finally, it tells the user to relocate the site to a new location and establish communications.

The instruction to press the space bar to exit then appears because the main clause has the "prob_is" clause satisfied and the "clear_facts" clause is initiated. Once a user does this the program will return to DOS and the program must be started again by typing MCTA at the DOS prompt.

4.2 System Power Outage Problem

A typical system problem can be illustrated with the system power outage problem in Appendix C (See page 109). The initial output is the same as the site profile problem. The method of moving through the program from the main clause to the "prob_is" section, the inference engine, the "ask" section and "remember" section is similar to the site

profile problem discussed in 4.1. It asks the first question and also gets a yes answer. But at the second question concerning if all the systems on a site were affected, a no answer means it is not a site problem so the program skips all other site problems.

> Do you have a problem you need assistance with somewhere in the Division communications system?
> yes
> Does the problem affect all the multichannel communications systems on a site?
> no

It asks if all the channels on the system were affected indicating it is a system problem. A yes answer brings it to the second system question asking if all contact was suddenly lost on the system.

> Does the problem affect all the channels on a particular system?
> yes
> Once the system was properly established, was all contact suddenly lost?
>
> yes

A yes answer satisfies the system power outage diagnosis and it will ask if you want to make any changes and after a no answer it will print out the problem as a system power outage.

> Would you like to make any changes to the answers provided above by starting over and making the correct entry?
> no
>
> Your problem may be a system power outage.

The program then displays the actions to solve the system power outage problem.

Actions to Solve System Power Outage

1. Turn off main circuit breaker on van power panel.
2. Check for damaged power cable.
3. Ensure circuit breakers are operating properly.
4. Switch to back-up generator if available.
5. Check fuel and oil levels in out of service generator.
6. Check fuel filters for cleanliness and serviceability.
7. Check for overall serviceability of generator.
8. Ensure frequency and voltage levels are correct prior to flipping the circuit breaker.

There are eight steps dealing with what to do to protect the equipment and restart back-up power. The output concludes with the press the space bar to exit statement.

4.3 Multichannel Antenna Problem

Another system problem is illustrated with the more complicated multichannel antenna problem found in Appendix C (See page 110). The initial statements and first two questions remain the same as in sections 4.1 and 4.2. The method of working through the program also remains the same. The third and fourth questions will be repeated here for continuity along with the fifth question in the decision tree.

Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
no
Have the multichannel operators been able to get good

loopbacks from another location?
no

The program proceeds to ask a string of questions in order to work its way down through the decision tree in a logical manner. Whenever it receives a no answer it goes on and asks the next question in the line. This process occurs due to the order in which the "prob_is" statements were arranged. If any "positive" predicate is not given a "yes" answer the entire rule is false. The program will go on to the next "prob_is" rule that does not contain the "no" answer in the database. The "positive" predicate looks to see if there was a previous answer to a particular question prior to asking the same question. The order of the questions and answers down to the multichannel antenna problem question are as follows:

Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
no
Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
no
Does the patch panel operator receive a good signal but the switchboard operator does not?
no
Is the multichannel operator unable to establish a good multichannel system?
yes

The last question has a "yes" answer because it establishes the problem as being a multichannel system problem. If a no answer were given the entire block of multichannel related problems would be skipped because each time the program

would look at a multichannel problem it would see the "no" answer in the database. The program finally asks the question about the multichannel antenna and a "yes" answer completes the diagnosis. The user is asked if any changes are desired and the problem is displayed.

> Does the multichannel operator get a high reflect power from the antenna system?
> yes
> Would you like to make any changes to the answers provided above by starting over and making the correct entry?
> no

Your problem may be with a system multichannel antenna. The actions to solve the problem are displayed as before.

> Actions to Solve Multichannel Antenna Problem
>
> 1. Switch to a back-up antenna system if available.
> 2. Lower antenna and check coax cable with the dummy load at the end of the cable for reflect power readings. If the readings are poor then replace the coax cable until good reflect power readings are established.
> 3. If coax cable is good then check the antenna connections for water or damage to the antenna. Replace an antenna if it has been damaged or good reflect readings cannot be obtained once the coax cable has been checked good.

4.4 Switchboard Central Processing Unit Problem

An example circuit problem deals with common user switchboard circuits being down on the multichannel system due to problems with the switchboard's central processing unit (CPU). The output for this problem can be found in Appendix C (See page 116). The first two questions and the method for moving around the program remain the same as

sections 4.1, 4.2, and 4.3. However, the answer to the third question is no which bypasses all the other system questions.

> Does the problem affect all the channels on a particular system?
> no
> Does the problem affect only specific circuits on a system?
> yes

The "yes" answer to the last question specifies the problem as being a circuit related problem versus a site or system problem. The next few questions allow the program to work its way down to the switchboard CPU problem.

> Does the multichannel operator have a good circuit path to the distant system end, but the next local operator in the circuit path cannot receive an adequate signal?
> no
> Does the patch panel operator have a good circuit path to the other end, but the switchboard operator cannot receive an adequate signal?
> no
> Does the circuit path stop at the multichannel system?
> no
> Is the switchboard a TTC-41?
> yes
> Does the problem circuit not have the proper features or is not operating once a circuit path has been established?
> no

The system finally asks about a common symptom with CPU memory problems or computer hardware problems. The "yes" answer and the question about making changes lead to the probable problem statement.

> Do the switchboard circuits not work or sporadic problems are occurring like ghost rings or calls dropping off?
> yes

Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a TTC-41 central processing unit trouble.

Actions to solve the problem and exiting instructions are displayed as in previous sections.

Actions to Solve TTC-41 CPU Problem

1. Ensure all function checks can be performed on the CPU.
2. Ensure the proper printouts are obtained when accessing the CPU's RAM.
3. Follow the appropriate troubleshooting guide in the Technical Manual.
4. Contact electronic maintenance support for assistance.

CHAPTER 5 Program Problem Resolution Flow

5.1 Program Declarations

PROLOG has a 64K code limit for each program if it is to stand alone. The MCTA program exceeds this limit so it must be broken up into two modules and linked during compilation using a project designator on the first line of each module. Appendix A contains the source code for the MCTA and MCTA1 modules. Each module must begin with some program declarations which state all of the parameters the program is to run under. These declarations are as follows:

```
project "MYMCTA"
code = 1900

database
  xpositive(symbol)
  xnegative(symbol)

global predicates
  resp(symbol)-(i)

predicates
  run
  clear_facts
  ask(symbol)
  remember(symbol,symbol)
  positive(symbol)
  negative(symbol)
  sys_is(symbol)
  cir_is(symbol)
  prob_is(symbol)

goal
  run.
```

After the project designation of "MYMCTA" a code length designation is used to manage the memory allocation of the program so only enough space is allocated for what is required by the code to compile. Next in the MCTA module

the database is declared by setting the type of "xpositive" and "xnegative" equal to a symbol. With modular programming any predicate to be seen by more than the main module must have its predicates declared in a global predicates section. Both of the modules have the same global predicates section listing "resp" as a global predicate of symbol type with an expected flow pattern of one input symbol.

The declarations continue in the main MCTA module with the predicates section. The standard predicates "run" and "clear_facts" do not need to have their type declared but all other predicates must declare their type. In this case all other predicates use symbols as their type. The "remember" predicate has two input arguments namely "yes or no" and the ask codeword. Finally, the goal section states the goal of "run." which is the main clause to be executed.

5.2 User Interface System

The clause section of the MCTA and MCTA1 modules begin with the user interface system containing all of the interaction between the program and the user on the monitor and keyboard. This user interface begins as follows:

```
run:-
 clearwindow,
 write("\n\nWelcome to Military Communications
Troubleshooting Aid(MCTA)."),nl,
 write("\nAnswer the following questions to determine a
probable"),nl,
 write("cause and response for your multichannel
communications problem.\n"),
```

```
 write("Answer questions using lowercase yes or
no.\n"),
 write("You may also obtain a communications site
installation guide by\n"),
 write("indicating you do not have a problem and want
the guide.\n\n"),
 write("Intentional pauses have been inserted in the
program for screen\n"),
 write("readability.  To continue press any key.\n\n"),
 prob_is(_),
 clear_facts.

/* Ask Questions Section */

ask(problem):-
 write("\nDo you have a problem you need assistance
with somewhere"),nl,
 write("in the Division communications system?\n"),
 readln(Reply),
 remember(problem,Reply).
```

The MCTA module contains the main clause "run" which has a welcome statement and some instructions for a user to run the program. The main clause "run" also contains the main program objective of finding a solution to the predicate "prob_is(_)". It is this predicate which drives all other actions in the program.

The user interface system continues in the MCTA module with 87 different questions contained under the "ask" clause (See pages 44 to 57). These "ask" clauses have a separate symbol codeword associated with them. Once the question is asked the program executes a "readln" and waits for the user to reply "yes" or "no". The answer is correlated with the codeword under the "remember" clause and stored in the database for later retrieval. The "prob_is" clauses have some user interface elements in them because they will print

out the probable problem once a match has succeeded and call the response actions.

5.3 Production Rules

The production rules all are contained within the predicate "prob_is" and are called in sequence from the main clause. (See pages 57 to 69) An example production rule is as follows:

```
prob_is(line_of_sight_profile) if
 positive(problem),
 positive(site),
 positive(profile),
 not(positive(changes)),!,
 write("\n\nYour problem may be a line of sight
 profile."),nl,nl,
 resp(line_of_sight_profile).
```

Each "prob_is" clause has a symbol identifying it for troubleshooting purposes. It is constructed as an if statement that will be true if the other clauses contained in it are proven to be true by the inference engine. Each rule has the "positive" predicate with a "ask" codeword in it so that the questions are asked in the order that they appear in the "prob_is" clauses. Once a particular rule has all of it's "positive" predicates satisfied a cut symbol, "!", is encountered which prevents the system from backtracking to find another solution. The rule then will print out what the probable problem is and make a call to the "resp" clauses contained in the MCTA1 module to print out the actions to take to solve the problem. If a

particular rule has one of it's "positive" predicates receive a "no" answer then the rule is false and the system will continue down the list of rules until one can be found which does not contain the false predicate. In most cases this will mean the next rule or the next section of rules. However, answering "no" to the first question if there is a problem will jump the program all the way to the last rule where it will ask if the user wants a site installation guide. If no rules can be satisfied then the program jumps to the "clear_facts" section and terminates the session. The last question asked under each rule after all other parts of the rule have been satisfied is if the user wants to make any changes. This ability of the program to correct input provided by the user is very valuable to prevent having to restart the entire program when a mistake is made. If a user answers "yes" to the question the program will take the cuts out of the program and proceed to ask questions working its way up and down the decision tree until it arrives at the conclusion. Based on the answers provided by the user, if no logical conclusions can be made thus no rules are completely satisfied then the expert system will tell the user that the answers provided were inconclusive to determine a possible problem.

5.4 Definition Rules

The production rules are constructed with many "positive" predicates that have to be satisfied before the rule can be fired and print out it's problem and actions. The task of typing all these "positive" predicates is simplified by using some system and circuit definition rules (See pages 69 to 71). An example of a system definition rule is as follows:

```
sys_is(sys):-
  positive(problem),
  positive(system).
```

Each one of the system or circuit definition rules list the "positive" predicates to be called under the "prob_is" rule. In this way several lines of code can be saved and the program will execute faster because it is not reading so many extra lines. This programming technique is very beneficial because it helps the programmer keep track of where you are at and shows which rules belong together. Often certain definition rules are used in the definition of additional definition rules which further simplifies the process.

5.5 Inference Engine

The inference engine section is the brains of the MCTA program because it tells the rules how to use the information in the knowledge base and tells the user

interface system what questions to ask and what responses to print out. The inference engine is as follows:

```
positive(X) if xpositive(X),!.

positive(X) if not(negative(X)),!, ask(X).

negative(X) if xnegative(X),!.

remember(X,yes):-
  asserta(xpositive(X)).

remember(X,no):-
  asserta(xnegative(X)), fail.

clear_facts:-
  retract(xpositive(_)), fail.

clear_facts:-
  retract(xnegative(_)), fail.

clear_facts:-
  write("\n\nPlease press the space bar to exit\n"),
  readchar(_).
```

The inference engine contains the predicates "positive" and "negative" which control the establishment of database items. The second "positive" clause checks for a non-negative condition and then prompts the "ask" predicate to ask the question associated with the codeword contained in the "positive" predicate. The "remember" clause has a "yes" version which stores all yes answers with the problem codeword under the "asserta xpositive" section of the database. It also has a negative type which stores all "no" answers with their codewords under the "asserta xnegative" section of the database. The last three clauses are

"clear_facts" predicates which clears the database of all values and gives user exiting instructions.

5.6 Response

The user interface system is continued under the second module of the project, MCTA1, containing all the "resp" predicates (See pages 72 to 98). An example of a response predicate is as follows:

```
resp(line_of_sight_profile):-
 write("\n\n\tActions to Solve Line of Sight
Problem"),nl,nl,
 write("1. Conduct a map reconnaissance to locate a
higher site that"),nl,
 write("all multichannel systems can reach."),nl,
 write("2. Contact higher level signal planning element
for assistance"),nl,
 write("in conducting computer assisted
profiling."),nl,
 write("3. Relocate communications site to new location
and establish"),nl,
 write("communications with all locations.\n").
```

The MCTA1 module contains the project declaration and a code size designator in addition to the global predicate declaration of "resp(symbol)-(i)". The clauses contained in the module are all "resp" predicates with the same codewords as those under the "prob_is" problems. Once a particular "prob_is" rule has been satisfied then the "resp" predicate pertaining to that problem is called from the MCTA1 module and shown on the screen. Several times the length of the actions to be taken exceed what one screen will accommodate. Intentional pauses were inserted in the code by using

"readchar(_)" methods to allow the user the time to read the screen before going on.

CHAPTER 6 Conclusions

The Military Communications Troubleshooting Aid can provide a valuable asset for a Division Signal Battalion Systems Control Element. It should be used as an off-line teaching aid for new or inexperienced controllers at the battalion or company level. The usefulness of this aid could be invaluable if a problem arises that is not normally encountered or some ideas are needed to deal with any problem. This program can only be used to its fullest extent in a unit that is using Tri-Tac equipment and has not converted to mobile subscriber equipment. The use of PROLOG as the programming language for this project was very useful and will save money on implementation because it can be run on existing equipment and the program is very easy to maintain.

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APPENDIX A: Program Source Code
A.1: MCTA.PRO

```
/* MCTA
  This expert system was developed by Major Douglas L.
Machamer as a troubleshooting aid for U.S. Army multichannel
communications systems controllers located in the Systems
Control Element of a Division Signal Battalion.  The program
is an off-line aid titled "Military Communications
Troubleshooting Aid" (MCTA).  It is a rule-based system
using a set of production rules for the purpose of
inferring.
*/

  project "MYMCTA"
  code = 1900

  database
    xpositive(symbol)
    xnegative(symbol)

  global predicates
    resp(symbol)-(i)

  predicates
    run
    clear_facts
    ask(symbol)
    remember(symbol,symbol)
    positive(symbol)
    negative(symbol)
    sys_is(symbol)
    cir_is(symbol)
    prob_is(symbol)

  goal
    run.

  clauses
          /* USER INTERFACE SYSTEM */

    /* Main Clause With Welcome Statements and Program
Instructions */

    run:-
      clearwindow,
      write("\n\nWelcome to Military Communications
Troubleshooting Aid(MCTA)."),nl,
      write("\nAnswer the following questions to determine a
probable"),nl,
      write("cause and response for your multichannel
communications problem.\n"),
```

```
      write("Answer questions using lowercase yes or
no.\n"),
      write("You may also obtain a communications site
installation guide by\n"),


      write("indicating you do not have a problem and want
the guide.\n\n"),
      write("Intentional pauses have been inserted in the
program for screen\n"),
      write("readability.  To continue press any key.\n\n"),
      prob_is(_),
      clear_facts.

    /* Ask Questions Section */

    ask(problem):-
      write("\nDo you have a problem you need assistance
with somewhere"),nl,
      write("in the Division communications system?\n"),
      readln(Reply),
      remember(problem,Reply).

    ask(site):-
      write("\nDoes the problem affect all the multichannel
communications"),nl,
      write("systems on a site?\n"),
      readln(Reply),
      remember(site,Reply).

    ask(profile):-
      write("\nOnce the communications site has been
established and"),nl,
      write("confirmed to be operating properly is it still
impossible"),nl,
      write("to receive an adequate multichannel signal to
all other"),nl,
      write("locations?\n"),
      readln(Reply),
      remember(profile,Reply).

    ask(power):-
      write("\nHas all contact to the communications site
been suddenly"),nl,
      write("lost on all systems?\n"),
      readln(Reply),
      remember(sitepwr,Reply).
```

```
    ask(emp):-
      write("\nHas there been a nuclear explosion in the
vicinity of"),nl,
      write("the affected site?\n"),
      readln(Reply),
      remember(emp,Reply).

    ask(system):-
      write("\nDoes the problem affect all the channels on a
particular"),nl,
      write("system?\n"),
      readln(Reply),
      remember(system,Reply).

    ask(syspwr):-
      write("\nOnce the system was properly established, was
all contact"),nl,
      write("suddenly lost?\n"),
      readln(Reply),
      remember(syspwr,Reply).

    ask(syspro):-
      write("\nHave the multichannel operators been able to
get good"),nl,
      write("loopbacks from another location?\n"),
      readln(Reply),
      remember(syspro,Reply).

    ask(syscbl):-
      write("\nDoes the multichannel operator have a good
system but"),nl,
      write("the next operator in the circuit path cannot
receive"),nl,
      write("any contact?\n"),
      readln(Reply),
      remember(syscbl,Reply).

    ask(sysrfi):-
      write("\nDoes the multichannel operator experience
noise on the"),nl,
      write("system that goes away if the frequency is
changed?\n"),
      readln(Reply),
      remember(sysrfi,Reply).

    ask(sysptch):-
      write("\nDoes the patch panel operator receive a good
signal but"),nl,
      write("the switchboard operator does not?\n"),
      readln(Reply),
      remember(sysptch,Reply).
```

```
    ask(sysmult):-
      write("\nIs the multichannel operator unable to
establish a good"),nl,
      write("multichannel system?\n"),
      readln(Reply),
      remember(sysmult,Reply).

    ask(sysmultant):-
      write("\nDoes the multichannel operator get a high
reflect power"),nl,
      write("from the antenna system?\n"),
      readln(Reply),
      remember(sysmultant,Reply).

    ask(sysmultrdo):-
      write("\nDoes the multichannel operator obtain a low
received"),nl,
      write("signal on the receiver or a low power out on
the transmitter?\n"),
      readln(Reply),
      remember(sysmultrdo,Reply).

    ask(rt773):-
      write("\nDoes the orderwire not function properly for
the radio?\n"),
      readln(Reply),
      remember(rt773,Reply).

    ask(pwrind773):-
      write("\nDoes the power indicator light on the RT-773
not work?\n"),
      readln(Reply),
      remember(pwrind773,Reply).

    ask(tone773):-
      write("\nIs the multichannel operator unable to detect
a 1600 Hz"),nl,
      write("tone over the system?\n"),
      readln(Reply),
      remember(tone773,Reply).

    ask(contact773):-
      write("\nCan the multichannel operator not make
orderwire contact"),nl,
      write("over the radio system once good residuals are
obtained?\n"),
      readln(Reply),
      remember(contact773,Reply).
```

```
    ask(r1329):-
      write("\nDoes the radio receiver not function
properly?\n"),
      readln(Reply),
      remember(r1329,Reply).

    ask(pwrind1329):-
      write("\nDoes the power indicator light on the R-1329
not work?\n"),
      readln(Reply),
      remember(pwrind1329,Reply).

    ask(volt1329):-
      write("\nDoes the multichannel operator have improper
voltage"),nl,
      write("level readings on the R-1329?\n"),
      readln(Reply),
      remember(volt1329,Reply).

    ask(sigind1329):-
      write("\nDoes the multichannel operator have improper
signal"),nl,
      write("level readings on the R-1329?\n"),
      readln(Reply),
      remember(sigind1329,Reply).

    ask(pcm1329):-
      write("\nIs the multichannel operator unable to obtain
12"),nl,
      write("channel PCM on the R-1329?\n"),
      readln(Reply),
      remember(pcm1329,Reply).

    ask(t983):-
      write("\nDoes the radio transmitter not function
properly?\n"),
      readln(Reply),
      remember(t983,Reply).

    ask(pwrind983):-
      write("\nDoes the power indicator light on the T-983
not work?\n"),
      readln(Reply),
      remember(pwrind983,Reply).

    ask(volt983):-
      write("\nDoes the multichannel operator have improper
voltage"),nl,
      write("level readings on the T-983?\n"),
      readln(Reply),
      remember(volt983,Reply).
```

```
    ask(pwrsig983):-
      write("\nDoes the multichannel operator have improper
signal"),nl,
      write("level readings on the T-983?\n"),
      readln(Reply),
      remember(pwrsig983,Reply).

    ask(pcm983):-
      write("\nIs the multichannel operator unable to obtain
12"),nl,
      write("channel PCM on the T-983?\n"),
      readln(Reply),
      remember(pcm983,Reply).

    ask(sysmultmux):-
      write("\nIs the multichannel operator unable to get
the channels"),nl,
      write("to frame up or the channels are noisey?\n"),
      readln(Reply),
      remember(sysmultmux,Reply).

    ask(td754):-
      write("\nDoes the TD-754/204 appear to be not mixing
the multiplexed"),nl,
      write("signals into a bit stream to be passed on the
cable system?\n"),
      readln(Reply),
      remember(td754,Reply).

    ask(pwrind754):-
      write("\nDoes the power indicator light on the TD-
754/204 not work?\n"),
      readln(Reply),
      remember(pwrind754,Reply).

    ask(volt754):-
      write("\nDoes the multichannel operator have improper
voltage"),nl,
      write("level readings on the TD-754/204?\n"),
      readln(Reply),
      remember(volt754,Reply).

    ask(mile754):-
      write("\nDoes the multichannel operator have improper
mileage"),nl,
      write("settings on the TD-754/204?\n"),
      readln(Reply),
      remember(mile754,Reply).
```

```
    ask(alph754):-
      write("\nDoes the multichannel operator have improper
alphabet"),nl,
      write("indications on the TD-754/204?\n"),
      readln(Reply),
      remember(alph754,Reply).

    ask(pcm754):-
      write("\nDoes the multichannel operator obtain
improper levels"),nl,
      write("for PCM in/Timing in on the TD-754/204?\n"),
      readln(Reply),
      remember(pcm754,Reply).

    ask(td660):-
      write("\nIs the multichannel operator unable to talk
off of the"),nl,
      write("handset on the TD-660 channels and does the TD-
660 appear"),nl,
      write("to be not functioning properly?\n"),
      readln(Reply),
      remember(td660,Reply).

    ask(pwrind660):-
      write("\nDoes the power indicator light on the TD-660
not work?\n"),
      readln(Reply),
      remember(pwrind660,Reply).

    ask(volt660):-
      write("\nDoes the multichannel operator have improper
voltage"),nl,
      write("level readings on the TD-660?\n"),
      readln(Reply),
      remember(volt660,Reply).

    ask(alph660):-
      write("\nDoes the multichannel operator have improper
readings"),nl,
      write("on the TD-660 alphabet settings?\n"),
      readln(Reply),
      remember(alph660,Reply).

    ask(noise660):-
      write("\nDoes the noise generator on the TD-660 not
work properly?\n"),
      readln(Reply),
      remember(noise660,Reply).
```

```
    ask(osc660):-
      write("\nDoes the oscillator on the TD-660 not
function properly?\n"),
      readln(Reply),
      remember(osc660,Reply).

    ask(pcm660):-
      write("\nDoes the multichannel operator obtain
improper levels"),nl,
      write("for PCM in/Timing in on the TD-660?\n"),
      readln(Reply),
      remember(pcm660,Reply).

    ask(cv1548):-
      write("\nDo the CV-1548 ringer cards not convert
signals or"),nl,
      write("ring properly?\n"),
      readln(Reply),
      remember(cv1548,Reply).

    ask(pwrind1548):-
      write("\nDoes the power indicator light on the CV-1548
not work?\n"),
      readln(Reply),
      remember(pwrind1548,Reply).

    ask(dr154820Hz):-
      write("\nDoes the 20 Hz drive on the CV-1548 not
function properly?\n"),
      readln(Reply),
      remember(dr154820Hz,Reply).

    ask(card154818A3B):-
      write("\nIs the multichannel operator unable to get
the 18A3B"),nl,
      write("ringer cards on the CV-1548 to light and ring
on AC mode?\n"),
      readln(Reply),
      remember(card154818A3B,Reply).

    ask(td1065):-
      write("\nIs the TD-1065 multiplexor not functioning
properly?\n"),
      readln(Reply),
      remember(td1065,Reply).

    ask(pwrind1065):-
      write("\nDoes the power indicator light on the TD-1065
not work?\n"),
      readln(Reply),
      remember(pwrind1065,Reply).
```

```
    ask(volt1065):-
      write("\nDoes the multichannel operator have improper
voltage"),nl,
      write("level lights on the TD-1065?\n"),
      readln(Reply),
      remember(volt1065,Reply).

    ask(xtmrec1065):-
      write("\nDoes the multichannel operator have improper
lights on"),nl,
      write("the TD-1065 transmitter/receiver
indicator?\n"),
      readln(Reply),
      remember(xtmrec1065,Reply).

    ask(comchan1065):-
      write("\nDoes the multichannel operator have improper
lights on"),nl,
      write("the TD-1065 communications/channel
indicator?\n"),
      readln(Reply),
      remember(comchan1065,Reply).

    ask(td1069):-
      write("\nIs the TD-1069 multiplexor not functioning
properly?\n"),
      readln(Reply),
      remember(td1069,Reply).

    ask(pwrind1069):-
      write("\nDoes the power indicator light on the TD-1069
not work?\n"),
      readln(Reply),
      remember(pwrind1069,Reply).

    ask(dcout1069):-
      write("\nDoes the multichannel operator obtain
improper DC output"),nl,
      write("lights on the TD-1069?\n"),
      readln(Reply),
      remember(dcout1069,Reply).

    ask(rate1069):-
      write("\nDoes the multichannel operator obtain
improper lights"),nl,
      write("on the TD-1069 rate/function/traffic
alarms?\n"),
      readln(Reply),
      remember(rate1069,Reply).
```

```
    ask(port1069):-
      write("\nDoes the multichannel operator have improper
port lights"),nl,
      write("on the TD-1069?\n"),
      readln(Reply),
      remember(port1069,Reply).

    ask(assign1069):-
      write("\nDoes the multichannel operator have improper
assignment"),nl,
      write("lights on the TD-1069?\n"),
      readln(Reply),
      remember(assign1069,Reply).

    ask(sysmultcry):-
      write("\nDoes the multichannel operator have timing
hits or a"),nl,
      write("rushing noise on the channels and is unable to
get a good"),nl,
      write("loopback?\n"),
      readln(Reply),
      remember(sysmultcry,Reply).

    ask(kgpwrind):-
      write("\nDoes the power indicator light on the KG-27
not work?\n"),
      readln(Reply),
      remember(kgpwrind,Reply).

    ask(kgkey):-
      write("\nHas the multichannel operator improperly set
the keylist"),nl,
      write("on the KOK cards and been unable to get a good
loopback"),nl,
      write("inhouse or from a distant site?\n"),
      readln(Reply),
      remember(kgkey,Reply).

    ask(sysmultwire):-
      write("\nDoes there appear to be a circuit path
problem on the"),nl,
      write("multichannel making it impossible to go beyond
the CV-1548?\n"),
      readln(Reply),
      remember(sysmultwire,Reply).
```

```
    ask(dataswbox):-
      write("\nDoes the multichannel operator have a good
signal path up"),nl,
      write("to the data switch box but not to the binding
posts?\n"),
      readln(Reply),
      remember(dataswbox,Reply).

    ask(dsbsyssw):-
      write("\nIs the system switch on the data switch box
in the"),nl,
      write("incorrect position or not functioning
properly?\n"),
      readln(Reply),
      remember(dsbsyssw,Reply).

    ask(dsbaudio):-
      write("\nIs the audio/data switch on the data switch
box in the"),nl,
      write("incorrect position or not functioning
properly?\n"),
      readln(Reply),
      remember(dsbaudio,Reply).

    ask(video):-
      write("\nDoes the multichannel operator have a good
signal path"),nl,
      write("before the video interconnect/binding post
box?\n"),
      readln(Reply),
      remember(video,Reply).

    ask(vidcon):-
      write("\nHave there been improper connections made to
the signal"),nl,
      write("entrance box with 26 pair cable or wire?\n"),
      readln(Reply),
      remember(vidcon,Reply).

    ask(vidchan):-
      write("\nHave the channels been improperly set on the
binding post"),nl,
      write("box or connected on the incorrect
terminals?\n"),
      readln(Reply),
      remember(vidchan,Reply).

    ask(circuit):-
      write("\nDoes the problem affect only specific
circuits on a system?\n"),
      readln(Reply),
      remember(circuit,Reply).
```

```
    ask(circbl):-
      write("\nDoes the multichannel operator have a good
circuit path"),nl,
      write("to the distant system end, but the next local
operator in the"),nl,
      write("circuit path cannot receive an adequate
signal?\n"),
      readln(Reply),
      remember(circbl,Reply).

    ask(cirptch):-
      write("\nDoes the patch panel operator have a good
circuit path to"),nl,
      write("the other end, but the switchboard operator
cannot receive"),nl,
      write("an adequate signal?\n"),
      readln(Reply),
      remember(cirptch,Reply).

    ask(cirmult):-
      write("\nDoes the circuit path stop at the
multichannel system?\n"),
      readln(Reply),
      remember(cirmult,Reply).

    ask(cirwr):-
      write("\nCan the multichannel operator talk to the
subscriber off"),nl,
      write("of the binding posts but not from the TD-660 or
CV-1548?\n"),
      readln(Reply),
      remember(cirwr,Reply).

    ask(cirmux):-
      write("\nDo other circuits work through the
multichannel multiplexing"),nl,
      write("equipment but not specific channels?\n"),
      readln(Reply),
      remember(cirmux,Reply).

    ask(cir660):-
      write("\nIs the multichannel operator unable to talk
off of the"),nl,
      write("handset on the TD-660 for the specific
channel?\n"),
      readln(Reply),
      remember(cir660,Reply).
```

```
    ask(cir660swset):-
      write("\nDoes the circuit appear to only be working
one direction?\n"),
      readln(Reply),
      remember(cir660swset,Reply).

    ask(cir660chanalign):-
      write("\nDoes the circuit have some distortion or only
works"),nl,
      write("with certain types of circuits?\n"),
      readln(Reply),
      remember(cir660chanalign,Reply).

    ask(cir660chancard):-
      write("\nDoes the circuit path stop at the TD-660 but
continues"),nl,
      write("once the channel card is changed?\n"),
      readln(Reply),
      remember(cir660chancard,Reply).

    ask(cir1548):-
      write("\nDo the CV-1548 ringer cards not convert
signals or ring"),nl,
      write("properly?\n"),
      readln(Reply),
      remember(cir1548,Reply).

    ask(cir1548swset):-
      write("\nDoes the circuit only work in one mode?\n"),
      readln(Reply),
      remember(cir1548swset,Reply).

    ask(cir1548rngcard):-
      write("\nIs the circuit path good to the CV-1548 but
not to the user or"),nl,
      write("does not ring in the AC mode?\n"),
      readln(Reply),
      remember(cir1548rngcard,Reply).

    ask(cir41):-
      write("\nIs the switchboard a TTC-41?\n"),
      readln(Reply),
      remember(cir41,Reply).

    ask(cir41data):-
      write("\nDoes the problem circuit not have the proper
features"),nl,
      write("or is not operating once a circuit path has
been established?\n"),
      readln(Reply),
      remember(cir41data,Reply).
```

```
    ask(cir41cpu):-
      write("\nDo the switchboard circuits not work or
sporadic problems"),nl,
      write("are occurring like ghost rings or calls
dropping off?\n"),
      readln(Reply),
      remember(cir41cpu,Reply).

    ask(cir41ptch):-
      write("\nDoes the incoming signal make it to the
switchboard's"),nl,
      write("patch panel but not to the CPU?\n"),
      readln(Reply),
      remember(cir41ptch,Reply).

    ask(cir41subeq):-
      write("\nDoes the subscriber's circuit work from the
users junction"),nl,
      write("box with similar test equipment but not with
the subcriber's"),nl,
      write("equipment?\n"),
      readln(Reply),
      remember(cir41subeq,Reply).

    ask(siteinst):-
      write("\nWould you like a printout of the steps to
properly install"),nl,
      write("a communications site?\n"),
      readln(Reply),
      remember(siteinst, Reply).

    ask(changes):-
      write("\nWould you like to make any changes to the
answers provided\n"),
      write("above by starting over and making the correct
entry?\n"),
      readln(Reply),
      remember(changes, Reply).

        /* PRODUCTION RULES FOR GENERAL SITE AND SYSTEM
PROBLEMS */

    prob_is(line_of_sight_profile) if
      positive(problem),
      positive(site),
      positive(profile),
      not(positive(changes)),!,
      write("\n\nYour problem may be a line of sight
profile."),nl,nl,
      resp(line_of_sight_profile).
```

```
    prob_is(site_power_outage) if
      positive(problem),
      positive(site),
      positive(power),
      not(positive(changes)),!,
      write("\n\nYour problem may be a site power
outage."),nl,nl,
      resp(site_power_outage).

    prob_is(electromagnetic_pulse_destroyed_circuitry) if
      positive(problem),
      positive(site),
      positive(emp),
      not(positive(changes)),!,
      write("\n\nYour problem may be an electromagnetic
pulse destroyed"),nl,
      write("circuitry."),nl,nl,
      resp(electromagnetic_pulse_destroyed_circuitry).

    prob_is(system_power_outage) if
      positive(problem),
      positive(system),
      positive(syspwr),
      not(positive(changes)),!,
      write("\n\nYour problem may be a system power
outage.\n\n"),
      resp(system_power_outage).

    prob_is(system_profile) if
      sys_is(sys),
      positive(syspro),
      not(positive(changes)),!,
      write("\n\nYour problem may be a system LOS
profile.\n\n"),
      readchar(_),
      resp(system_LOS_profile).

    prob_is(system_cabling) if
      sys_is(sys),
      positive(syscbl),
      not(positive(changes)),!,
      write("\n\nYour problem may be system cabling.\n\n"),
      resp(system_cabling).

    prob_is(system_radio_frequency_interference) if
      sys_is(sys),
      positive(sysrfi),
      not(positive(changes)),!,
      write("\n\nYour problem may be system radio frequency
interference.\n\n"),
      readchar(_),
      resp(system_radio_frequency_interference).
```

```
    prob_is(system_patch_panel_wiring) if
      sys_is(sys),
      positive(sysptch),
      not(positive(changes)),!,
      write("\n\nYour problem may be system patch panel
wiring.\n\n"),
      readchar(_),
      resp(patch_panel_trouble).

    /* PRODUCTION RULES FOR MULTICHANNEL SYSTEM PROBLEMS */

    prob_is(mult_antenna) if
      sys_is(sys),
      positive(sysmult),
      positive(sysmultant),
      not(positive(changes)),!,
      write("\n\nYour problem may be with a system
multichannel antenna.\n\n"),
      resp(multichannel_antenna_trouble).

    prob_is(sys_mult_RT773_pwrind) if
      sys_is(multrt773),
      positive(pwrind773),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("RT-773 power indicator.\n\n"),
      resp(rt773_power_indicator_trouble).

    prob_is(sys_mult_RT773_tone) if
      sys_is(multrt773),
      positive(tone773),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("RT-773 1600 Hz tone.\n\n"),
      resp(rt773_tone_trouble).

    prob_is(sys_mult_RT773_contact) if
      sys_is(multrt773),
      positive(contact773),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("RT-773 with no order wire contact.\n\n"),
      resp(rt773_contact_trouble).
```

```
    prob_is(sys_mult_R1329_pwrind) if
      sys_is(multr1329),
      positive(pwrind1329),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("R-1329 power indicator.\n\n"),
      resp(r1329_power_indicator_trouble).

    prob_is(sys_mult_R1329_volt) if
      sys_is(multr1329),
      positive(volt1329),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("R-1329 voltage levels.\n\n"),
      resp(r1329_voltage_level_trouble).

    prob_is(sys_mult_R1329_sigind) if
      sys_is(multr1329),
      positive(sigind1329),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("R-1329 signal indicator.\n\n"),
      resp(r1329_signal_indicator_trouble).

    prob_is(sys_mult_R1329_pcm) if
      sys_is(multr1329),
      positive(pcm1329),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("R-1329 12 channel PCM level.\n\n"),
      resp(r1329_PCM_trouble).

    prob_is(sys_mult_T983_pwrind) if
      sys_is(multt983),
      positive(pwrind983),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("T-983 power indicator.\n\n"),
      resp(t983_power_indicator_trouble).

    prob_is(sys_mult_T983_volt) if
      sys_is(multt983),
      positive(volt983),
      not(positive(changes)),!,
```

```
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("T-983 voltage levels.\n\n"),
      resp(t983_voltage_level_trouble).

    prob_is(sys_mult_T983_pwrsig) if
      sys_is(multt983),
      positive(pwrsig983),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("T-983 power/signal checks.\n\n"),
      resp(t983_power_signal_trouble).

    prob_is(sys_mult_T983_pcm) if
      sys_is(multt983),
      positive(pcm983),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("T-983 12 channel PCM level.\n\n"),
      resp(t983_PCM_trouble).

    prob_is(sys_mult_TD754_pwrind) if
      sys_is(multtd754),
      positive(pwrind754),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-754/204 power indicator.\n\n"),
      resp(td754_power_indicator_trouble).

    prob_is(sys_mult_TD754_volt) if
      sys_is(multtd754),
      positive(volt754),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-754/204 voltage levels.\n\n"),
      resp(td754_voltage_level_trouble).

    prob_is(sys_mult_TD754_mile) if
      sys_is(multtd754),
      positive(mile754),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-754/204 mileage settings.\n\n"),
      resp(td754_mileage_settings_trouble).
```

```
    prob_is(sys_mult_TD754_alph) if
      sys_is(multtd754),
      positive(alph754),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-754/204 alphabet indications.\n\n"),
      resp(td754_alphabet_switch_trouble).

    prob_is(sys_mult_TD754_pcm) if
      sys_is(multtd754),
      positive(pcm754),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-754/204 PCM in/Timing in settings.\n\n"),
      resp(td754_PCM_Timing_trouble).

    prob_is(sys_mult_TD660_pwrind) if
      sys_is(multtd660),
      positive(pwrind660),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 power indicator.\n\n"),
      resp(td660_power_indicator_trouble).

    prob_is(sys_mult_TD660_volt) if
      sys_is(multtd660),
      positive(volt660),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 voltage levels.\n\n"),
      resp(td660_voltage_level_trouble).

    prob_is(sys_mult_TD660_alph) if
      sys_is(multtd660),
      positive(alph660),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 alphabet settings.\n\n"),
      resp(td660_alphabet_switch_trouble).

    prob_is(sys_mult_TD660_noise) if
      sys_is(multtd660),
      positive(noise660),
      not(positive(changes)),!,
```

```
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 noise generator.\n\n"),
      resp(td660_noise_generator_trouble).

    prob_is(sys_mult_TD660_osc) if
      sys_is(multtd660),
      positive(osc660),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 oscillator.\n\n"),
      resp(td660_oscillator_trouble).

    prob_is(sys_mult_TD660_pcm) if
      sys_is(multtd660),
      positive(pcm660),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-660 PCM in/Timing in levels.\n\n"),
      resp(td660_PCM_Timing_trouble).

    prob_is(sys_mult_CV1548_pwrind) if
      sys_is(multcv1548),
      positive(pwrind1548),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("CV-1548 power indicator.\n\n"),
      resp(cv1548_power_indicator_trouble).

    prob_is(sys_mult_CV1548_20Hzdr) if
      sys_is(multcv1548),
      positive(dr154820Hz),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("CV-1548 20 Hz drive.\n\n"),
      resp(cv1548_20Hz_drive_trouble).

    prob_is(sys_mult_CV1548_18A3B) if
      sys_is(multcv1548),
      positive(card154818A3B),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("CV-1548 18A3B circuits.\n\n"),
      resp(cv1548_ringer_card_trouble).
```

```
    prob_is(sys_mult_TD1065_pwrind) if
      sys_is(multtd1065),
      positive(pwrind1065),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1065 power indicator.\n\n"),
      resp(td1065_power_indicator_trouble).

    prob_is(sys_mult_TD1065_volt) if
      sys_is(multtd1065),
      positive(volt1065),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1065 voltage levels.\n\n"),
      resp(td1065_voltage_level_trouble).

    prob_is(sys_mult_TD1065_xtmrec) if
      sys_is(multtd1065),
      positive(xtmrec1065),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1065 transmitter/receiver indicator.\n\n"),
      resp(td1065_transmitter_receiver_trouble).

    prob_is(sys_mult_TD1065_comchan) if
      sys_is(multtd1065),
      positive(comchan1065),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1065 communications/channel
indicator.\n\n"),
      resp(td1065_communications_channel_trouble).

    prob_is(sys_mult_TD1069_pwrind) if
      sys_is(multtd1069),
      positive(pwrind1069),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1069 power indicator.\n\n"),
      resp(td1069_power_indicator_trouble).

    prob_is(sys_mult_TD1069_DCout) if
      sys_is(multtd1069),
      positive(dcout1069),
      not(positive(changes)),!,
```

```
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1069 DC output level.\n\n"),
      resp(td1069_DC_output_trouble).

    prob_is(sys_mult_TD1069_rate) if
      sys_is(multtd1069),
      positive(rate1069),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1069 rate/function/traffic alarms.\n\n"),
      resp(td1069_rate_function_traffic_alarms_trouble).

    prob_is(sys_mult_TD1069_port) if
      sys_is(multtd1069),
      positive(port1069),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1069 port settings.\n\n"),
      resp(td1069_port_settings_trouble).

    prob_is(sys_mult_TD1069_assign) if
      sys_is(multtd1069),
      positive(assign1069),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("TD-1069 assign settings.\n\n"),
      resp(td1069_assign_settings_trouble).

    prob_is(sys_mult_KG27_pwrind) if
      sys_is(multcry),
      positive(kgpwrind),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("KG-27 power indicator.\n\n"),
      resp(kg27_power_indicator_trouble).

    prob_is(sys_mult_KG27_key) if
      sys_is(multcry),
      positive(kgkey),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("KG-27 keylist mismatch.\n\n"),
      resp(kg27_keylist_trouble).
```

```
    prob_is(sys_mult_datasb_syssw) if
      sys_is(multwire),
      positive(dataswbox),
      positive(dsbsyssw),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("data switch box system switch.\n\n"),
      resp(datasb_system_switch_trouble).

    prob_is(sys_mult_datasb_audio) if
      sys_is(multwire),
      positive(dataswbox),
      positive(dsbaudio),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("data switch box audio/data switch.\n\n"),
      resp(datasb_audio_data_switch_trouble).

    prob_is(sys_mult_video_connect) if
      sys_is(multwire),
      positive(video),
      positive(vidcon),
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("video int/binding post proper
connections.\n\n"),
      resp(video_proper_connections_trouble).

    prob_is(sys_mult_video_chan) if
      sys_is(multwire),
      positive(video),
      positive(vidchan)
      not(positive(changes)),!,
      write("\n\nYour problem may be with the system
multichannel,"),nl,
      write("video int/binding post correct channel.\n\n"),
      resp(video_proper_channel_trouble).

    /* PRODUCTION RULES FOR CIRCUIT PROBLEMS */

    /* General Circuit Problems */

    prob_is(site_circuit_path) if
      positive(problem),
      positive(circuit),
      positive(circbl),
      not(positive(changes)),!,
```

```
      write("\n\nYour problem may be a site circuit
path.\n\n"),
      resp(site_circuit_path).

    prob_is(site_patch_panel_circuit_wiring) if
      cir_is(cir),
      positive(cirptch),
      not(positive(changes)),!,
      write("\n\nYour problem may be a site patch panel
circuit wiring.\n\n"),
      resp(site_patch_panel_circuit_wiring).

    /* Multichannel Circuit Problems */

    prob_is(mult_circuit_wiring) if
      cir_is(cirmult),
      positive(cirwr),
      not(positive(changes)),!,
      write("\n\nYour problem may be with multichannel
circuit wiring.\n\n"),
      resp(multichannel_circuit_wiring_trouble).

    prob_is(mult_TD_660_swset) if
      cir_is(cirmux),
      positive(cir660),
      positive(cir660swset),
      not(positive(changes)),!,
      write("\n\nYour problem may be a multichannel, TD-
660"),nl,
      write("switch setting.\n\n"),
      resp(td660_switch_setting_trouble).

    prob_is(mult_TD_660_chanalign) if
      cir_is(cirmux),
      positive(cir660),
      positive(cir660chanalign),
      not(positive(changes)),!,
      write("\n\nYour problem may be a multichannel, TD-
660"),nl,
      write("channel card alignment.\n\n"),
      resp(td660_channel_alignment_trouble).

    prob_is(mult_TD_660_chancard) if
      cir_is(cirmux),
      positive(cir660),
      positive(cir660chancard),
      not(positive(changes)),!,
      write("\n\nYour problem may be a multichannel, TD-
660"),nl,
      write("bad channel card.\n\n"),
      resp(td660_channel_card_trouble).
```

```
    prob_is(mult_CV_1548_swset) if
      cir_is(cirmux),
      positive(cir1548),
      positive(cir1548swset),
      not(positive(changes)),!,
      write("\n\nYour problem may be a multichannel, CV-
1548"),nl,
      write("switch setting.\n\n"),
      resp(cv1548_switch_setting_trouble).

    prob_is(mult_CV_1548_rngcard) if
      cir_is(cirmux),
      positive(cir1548),
      positive(cir1548rngcard),
      not(positive(changes)),!,
      write("\n\nYour problem may be a multichannel, CV-1548
ringer"),nl,
      write("card trouble.\n\n"),
      resp(cv1548_circuit_ringer_card_trouble).

    /* TTC-41 Switchboard Problems */

    prob_is(ttc_41_database_trouble) if
      cir_is(cir),
      positive(cir41),
      positive(cir41data),
      not(positive(changes)),!,
      write("\n\nYour problem may be a TTC-41 database
trouble.\n\n"),
      resp(ttc41_database_trouble).

    prob_is(ttc_41_central_processing_unit_trouble) if
      cir_is(cir41),
      positive(cir41cpu),
      not(positive(changes)),!,
      write("\n\nYour problem may be a TTC-41 central
processing"),nl,
      write("unit trouble.\n\n"),
      resp(ttc41_central_processing_unit_trouble).

    prob_is(ttc_41_patch_panel_wiring_trouble) if
      cir_is(cir41),
      positive(cir41ptch),
      not(positive(changes)),!,
      write("\n\nYour problem may be a TTC-41 patch
panel"),nl,
      write("wiring trouble.\n\n"),
      resp(ttc41_patch_panel_wiring_trouble).
```

```
    prob_is(ttc_41_subscriber_equipment_trouble) if
      cir_is(cir41),
      positive(cir41subeq),
      not(positive(changes)),!,
      write("\n\nYour problem may be a TTC-41
subscriber"),nl,
      write("equipment trouble.\n\n"),
      readchar(_),
      resp(ttc41_subscriber_equipment_trouble).

     /* PRODUCTION RULE FOR SITE INSTALLATION GUIDE */

  prob_is(siteinst) if
    not(positive(problem)),
    positive(siteinst),
    resp(site_arrival),
    resp(multichannel_site),
    resp(general_site1),
    resp(general_site2),
    resp(general_site3).

     /* RULES FOR CHANGES AND NO SOLUTION */

  prob_is(changes) if
    positive(changes),
    retract(xpositive(_)),
    retract(xnegative(_)),
    prob_is(_).

  prob_is(no_solution) if
    write("\n\nThe answers provided were inconclusive to
determine a probable\n"),
    write("problem.  Restart the program if you wish to try
again.\n\n").

    /* System Definition Rules */

    sys_is(sys):-
      positive(problem),
      positive(system).

    sys_is(sysmult):-
      sys_is(sys),
      positive(sysmult).

    sys_is(multrdo):-
      sys_is(sysmult),
      positive(sysmultrdo).

    sys_is(multrt773):-
      sys_is(multrdo),
      positive(rt773).
```

```
sys_is(multr1329):-
  sys_is(multrdo),
  positive(r1329).

sys_is(multt983):-
  sys_is(multrdo),
  positive(t983).

sys_is(multmux):-
  sys_is(sysmult),
  positive(sysmultmux).

sys_is(multtd754):-
  sys_is(multmux),
  positive(td754).

sys_is(multtd660):-
  sys_is(multmux),
  positive(td660).

sys_is(multcv1548):-
  sys_is(multmux),
  positive(cv1548).

sys_is(multtd1065):-
  sys_is(multmux),
  positive(td1065).

sys_is(multtd1069):-
  sys_is(multmux),
  positive(td1069).

sys_is(multcry):-
  sys_is(sysmult),
  positive(sysmultcry).

sys_is(multwire):-
  sys_is(sysmult),
  positive(sysmultwire).

/* Circuit Definition Rules */

cir_is(cir):-
  positive(problem),
  positive(circuit).

cir_is(cirmult):-
  cir_is(cir),
  positive(cirmult).
```

```
cir_is(cirmux):-
  cir_is(cirmult),
  positive(cirmux).

cir_is(cir41):-
  cir_is(cir),
  positive(cir41).


/* INFERENCE ENGINE */

positive(X) if xpositive(X),!.

positive(X) if not(negative(X)),!, ask(X).

negative(X) if xnegative(X),!.

remember(X,yes):-
  asserta(xpositive(X)).

remember(X,no):-
  asserta(xnegative(X)), fail.

clear_facts:-
  retract(xpositive(_)), fail.

clear_facts:-
  retract(xnegative(_)), fail.

clear_facts:-
  write("\n\nPlease press the space bar to exit\n"),
  readchar(_).
```

A.2: MCTA1.PRO

```
/* MCTA1
This module is a continuation of MCTA containing the
responses to the problems contained in MCTA.  It is part of
the user interface system.
*/
  project "MYMCTA"
  code = 2900

  global predicates
    resp(symbol)-(i)

  clauses
          /* USER INTERFACE SYSTEM */

        /* Response To General Problems Section */

    resp(line_of_sight_profile):-
      write("\n\n\tActions to Solve Line of Sight
Problem"),nl,nl,
      write("1. Conduct a map reconnaissance to locate a
higher site that"),nl,
      write("all multichannel systems can reach."),nl,
      write("2. Contact higher level signal planning element
for assistance"),nl,
      write("in conducting computer assisted
profiling."),nl,
      write("3. Relocate communications site to new location
and establish"),nl,
      write("communications with all locations.\n").

    resp(site_power_outage):-
      write("\n\n\tActions to Solve Site Power
Outage"),nl,nl,
      write("1. Have all systems with back up power switch
to that power"),nl,
      write("source until the site central power can be
restored."),nl,
      write("2. Ensure central power circuit breakers are
off prior to"),nl,
      write("attempting repair actions."),nl,
      write("3. Ensure fuel level is adequate in set tanks
or external tanks"),nl,
      write("4. Check fuel filters for cleanliness and
serviceability."),nl,
      write("5. Check oil levels and overall serviceability
of generator."),nl,
      write("6. Ensure frequency and voltage levels are
correct prior to"),nl,
```

```
      write("reconnecting power cables and flipping the
circuit breaker.\n").

    resp(electromagnetic_pulse_destroyed_circuitry):-
      write("\n\n\tActions to Solve EMP Destroyed
Equipment"),nl,nl,
      write("1. Replace damaged power cables and signal
cables."),nl,
      write("2. Replace damaged antennas."),nl,
      write("3. Bring up back-up equipment on-line."),nl,
      write("4. Establish communications using RATT rig or
AM voice first."),nl,
      write("5. Reestablish multichannel communications
after coordination"),nl,
      write("with distant sites.\n").

    resp(system_power_outage):-
      write("\n\n\tActions to Solve System Power
Outage"),nl,nl,
      write("1. Turn off main circuit breaker on van power
panel."),nl,
      write("2. Check for damaged power cable."),nl,
      write("3. Ensure circuit breakers are operating
properly."),nl,
      write("4. Switch to back-up generator if
available."),nl,
      write("5. Check fuel and oil levels in out of service
generator."),nl,
      write("6. Check fuel filters for cleanliness and
serviceability."),nl,
      write("7. Check for overall serviceability of
generator."),nl,
      write("8. Ensure frequency and voltage levels are
correct prior to"),nl,
      write("flipping the circuit breaker.\n").

    resp(system_LOS_profile):-
      write("\n\n\tActions to Solve System Line of Sight
Problem"),nl,nl,
      write("1. Raise antenna until system residuals are
sufficient to"),nl,
      write("install multichannel communications."),nl,
      write("2. Relocate system to a higher location if one
is available"),nl,
      write("and install a cable system back to the
switchboard location."),nl,
      write("3. Change the antenna polarization to vertical
if it is"),nl,
      write("desired to shoot around an obstacle."),nl,
      write("4. If communications cannot be established for
the one system"),nl,
```

```
      write("then conduct a map reconnaissance to locate a
higher site that"),nl,
      write("all multichannel systems can reach."),nl,
      write("5. Contact higher level signal planning element
for assistance"),nl,
      write("in conducting computer assisted
profiling."),nl,
      write("6. Relocate communications site to new location
and establish"),nl,
      write("communications with all locations.\n").

    resp(system_cabling):-
      write("\n\n\tActions to Solve System Cabling
Problem"),nl,nl,
      write("1. Ensure 26 pair cable or PCM cable is
properly connected"),nl,
      write("to both vans that have the interconnection
problem."),nl,
      write("2. Have a cable team check for continuity of
the cable."),nl,
      write("3. Conduct a signal level meter test with the
cable from"),nl,
      write("the patch panel or a portable meter."),nl,
      write("4. Replace the defective cable if
necessary.\n").

    resp(system_radio_frequency_interference):-
      write("\n\nActions to Solve System Radio Frequency
Interference Problem"),
      write("\n\n1. Switch antenna to the dummy load to
ensure interference"),nl,
      write("is coming from an outside source."),nl,
      write("2. Change the polarization of the system."),nl,
      write("3. Flip flop the frequencies."),nl,
      write("4. Use the ABM frequency allocation system to
determine a new"),nl,
      write("set of frequencies that will work without
interference and then"),nl,
      write("switch to those new frequencies after they are
checked out for"),nl,
      write("similar interference problems."),nl,
      write("5. Ensure antenna is not in direct line with an
outside source"),nl,
      write("of interference such as a generator or a
Tactical Operations"),nl,
      write("Center."),nl,
      write("6. Contact higher level radio frequency manager
for a new set"),nl,
      write("of frequencies not already under your control
that will work."),nl,
      write("7. In a combat situation when communications
are critical, have"),nl,
```

```
      write("the controlling multichannel operator choose a
low frequency"),nl,
      write("and a high frequency away from all other
frequencies and check"),nl,
      write("for interference.  If no RFI is present on the
new frequencies"),nl,
      write("install the system and notify the frequency
manager of your"),nl,
      write("new frequencies as soon as possible.\n").

    resp(patch_panel_trouble):-
      write("\n\n\t\tAN/TSQ-84A Patch Panel Repair
Actions"),nl,nl,
      write("Malfunction 1: No indication on AC volt meter.
Line 1 and"),nl,
      write("Line 2 indicators do not light."),nl,
      write("Action: Check for defective power cable and
repair/replace."),nl,
      write("\nMalfunction 2: No indication on AC volt
meter.  Line 1 and"),nl,
      write("Line 2 indicators light."),nl,
      write("Action: Replace defective M2 meter or voltmeter
S1 switch."),nl,
      write("\nMalfunction 3: Abnormal indication on AC volt
meter."),nl,
      write("Action: Check for defective power source."),nl,
      write("\nMalfunction 4: AC volt meter indicates
normal, but no"),nl,
      write("indication on Line 1 indicator."),nl,
      write("Action: Replace defective Line 1 indicator
DS18."),nl,
      write("\nMalfunction 5: AC volt meter indicates
normal, but no"),nl,
      write("indication on Line 2 indicator."),nl,
      write("Action: Replace defective Line 2 indicator
DS17."),nl,
      write("\nMalfunction 6: Associated indicator does not
light when"),nl,
      write("circuit breaker is operated."),nl,
      write("Action: Replace defective indicator DS1-DS16 or
defective"),nl,
      write("circuit breaker CB1-CB15."),nl,
      readchar(_),
      write("\nMalfunction 7: Circuit path not continuous
from multichannel"),nl,
      write("to switchboard or other systems."),nl,
      write("Actions:"),nl,
      write("\t1. Check for proper 26 pair cable or wire
connections to van."),nl,
      write("\t2. Ensure wire and cable are good by using
signal meter test."),nl,
```

```
      write("\t3. Ensure proper patch cord connections per
circuit routing lists."),nl,
      write("\t4. Check for good patch cords with signal
meter."),nl,
      write("\t5. Clean patch cord ends and patch holes with
polishing cloth"),nl,
      write("or proper cleaning solution.\n").

    /* Response To Multichannel Problems Section */

    resp(multichannel_antenna_trouble):-
      write("\n\n\tActions to Solve Multichannel Antenna
Problem"),nl,nl,
      write("1. Switch to a back-up antenna system if
available."),nl,
      write("2. Lower antenna and check coax cable with the
dummy load"),nl,
      write("at the end of the cable for reflect power
readings.  If the"),nl,
      write("readings are poor then replace the coax cable
until good"),nl,
      write("reflect power readings are established."),nl,
      write("3. If coax cable is good then check the antenna
connections"),nl,
      write("for water or damage to the antenna.  Replace an
antenna if it"),nl,
      write("has been damaged or good reflect readings
cannot be obtained"),nl,
      write("once the coax cable has been checked good.\n").

    resp(rt773_power_indicator_trouble):-
      write("\n\n\tActions to Solve RT-773 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Replace RT-773 if all other actions
fail."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").
```

```
    resp(rt773_tone_trouble):-
      write("\n\n\tActions to Solve RT-773 Tone
Problem"),nl,nl,
      write("1. Replace the RT-773 first at the controlling
end and then"),nl,
      write("at the distant end."),nl,
      write("2. Contact electronic maintenance support for
assistance.\n").

    resp(rt773_contact_trouble):-
      write("\n\n\tActions to Solve RT-773 Contact
Problem"),nl,nl,
      write("1. Contact the distant end by another means to
ensure their"),nl,
      write("equipment is operational and the operator is
monitoring the"),nl,
      write("orderwire continuously."),nl,
      write("2. Replace the speaker in the RT-773."),nl,
      write("3. Replace the RT_773 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(r1329_power_indicator_trouble):-
      write("\n\n\tActions to Solve R-1329 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Replace R-1329 if all other actions
fail."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").

    resp(r1329_voltage_level_trouble):-
      write("\n\n\tActions to Solve R-1329 Voltage Level
Problem"),nl,nl,
      write("1. Replace the R-1329 at the end having
problems."),nl,
      write("2. Contact electronic maintenance support for
assistance.\n").
```

```
    resp(r1329_signal_indicator_trouble):-
      write("\n\n\tActions to Solve R-1329 Signal Indicator
Problem"),nl,nl,
      write("1. Replace the R-1329 at the end having
problems."),nl,
      write("2. Contact electronic maintenance support for
assistance.\n").

    resp(r1329_PCM_trouble):-
      write("\n\n\tActions to Solve R-1329 12 Channel PCM
Level Problem"),nl,nl,
      write("1. Ensure distant terminal or relay is sending
PCM prior to"),nl,
      write("changing equipment or conducting
maintenance."),nl,
      write("2. Tune the R-1329 to a frequency on a system
operating properly"),nl,
      write("to ensure it works."),nl,
      write("3. Check the cable path between the R-1329 PCM
OUT and the"),nl,
      write("TD-660 PCM IN."),nl,
      write("4. Replace the R-1329 at the end not indicating
PCM."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(t983_power_indicator_trouble):-
      write("\n\n\tActions to Solve T-983 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Replace T-983 if all other actions
fail."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").

    resp(t983_voltage_level_trouble):-
      write("\n\n\tActions to Solve T-983 Voltage Level
Problem"),nl,nl,
      write("1. Replace the T-983 at the end having
problems."),nl,
      write("2. Contact electronic maintenance support for
assistance.\n").
```

```
    resp(t983_power_signal_trouble):-
      write("\n\n\tActions to Solve T-983 Power/Signal
Checks Problem"),nl,nl,
      write("1. Replace the T-983 at the end having
problems."),nl,
      write("2. Contact electronic maintenance support for
assistance.\n").

    resp(t983_PCM_trouble):-
      write("\n\n\tActions to Solve T-983 12 Channel PCM
Level Problem"),nl,nl,
      write("1. Ensure PCM is being received and then make a
patch from"),nl,
      write("RCVR PCM OUT to XMTR PCM IN."),nl,
      write("2. Check path between TD-660 PCM OUT and XMTR
PCM IN."),nl,
      write("3. Replace the T-983 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td754_power_indicator_trouble):-
      write("\n\n\tActions to Solve TD-754/204 Power
Indicator Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Replace TD-754/204 if all other actions
fail."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").

    resp(td754_voltage_level_trouble):-
      write("\n\n\tActions to Solve TD-754/204 Voltage Level
Problem"),nl,nl,
      write("1. Adjust the voltage level or the voltage
meter."),nl,
      write("2. Check fuses corresponding to missing
voltage."),nl,
      write("3. Replace the TD-754/204 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").
```

```
    resp(td754_mileage_settings_trouble):-
      write("\n\n\tActions to Solve TD-754/204 Mileage
Settings Problem"),nl,nl,
      write("1. Adjust the mileage setting to the proper
distance for"),nl,
      write("the length of the cable system."),nl,
      write("2. Check for defective 12A4 or 12A5 CCA."),nl,
      write("3. Ensure there is orderwire contact with the
distant end."),nl,
      write("4. Troubleshoot and TD-206 repeaters in the
cable system."),nl,
      write("5. Replace the TD-754/204 at the end having
problems."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").

    resp(td754_alphabet_switch_trouble):-
      write("\n\n\tActions to Solve TD-754/204 Alphabet
Indication Problem"),nl,nl,
      write("1. Check the alphabet indications."),nl,
      write("2. Replace the corresponding CCA."),nl,
      write("3. Replace the TD-754/204 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td754_PCM_Timing_trouble):-
      write("\n\n\tActions to Solve TD-754/204 PCM/Timing
Problem"),nl,nl,
      write("1. Check the PCM in/Timing in indication."),nl,
      write("2. Check path between the TD-660, KG-27 and TD-
754."),nl,
      write("3. If there is no PCM/TIM indication on the TD-
754 the problem"),nl,
      write("is local and on the transmit side."),nl,
      write("4. Check the transmit side of the TD-660, path
to the KG-27"),nl,
      write("through the TD-1065 then the transmit side of
the KG-27,"),nl,
      write("path to the TD-754 or transmit side of TD-
754."),nl,
      write("5. Replace the TD-754/204 at the end having
problems."),nl,
      write("6. Contact electronic maintenance support for
assistance.\n").

    resp(td660_power_indicator_trouble):-
      write("\n\n\tActions to Solve TD-660 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
```

```
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Replace TD-660 if all other actions
fail."),nl,
      write("6. Check fuses."),nl,
      write("7. Replace power supply."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(td660_voltage_level_trouble):-
      write("\n\n\tActions to Solve TD-660 Voltage Level
Problem"),nl,nl,
      write("1. Adjust the voltage level or the voltage
meter."),nl,
      write("2. Replace the TD-660 at the end having
problems."),nl,
      write("3. Check fuses."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td660_alphabet_switch_trouble):-
      write("\n\n\tActions to Solve TD-660 Alphabet Switch
Problem"),nl,nl,
      write("1. Adjust the alphabet switch setting to obtain
the proper"),nl,
      write("reading or replace the alphabet switch if it is
defective."),nl,
      write("2. Replace corresponding CCA."),nl,
      write("3. Before replacing any CCA you must ensure
that you are getting"),nl,
      write("the corresponding signal from associated
equipment."),nl,
      write("4. Replace the TD-660 at the end having
problems."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(td660_noise_generator_trouble):-
      write("\n\n\tActions to Solve TD-660 Noise Generator
Problem"),nl,nl,
      write("1. Check the noise generator or replace the
11A25 CCA if"),nl,
      write("it is defective."),nl,
      write("2. Patch in the spare TD-660 and then
troubleshoot the bad part."),nl,
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      write("3. Replace the TD-660 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td660_oscillator_trouble):-
      write("\n\n\tActions to Solve TD-660 Oscillator
Problem"),nl,nl,
      write("1. Replace the 11A29 card."),nl,
      write("2. Replace the TD-660 at the end having
problems."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").

    resp(td660_PCM_Timing_trouble):-
      write("\n\n\tActions to Solve TD-660 PCM/Timing
Problem"),nl,nl,
      write("1. Check if it is a radio or cable system and
ensure proper"),nl,
      write("settings and connections."),nl,
      write("2. Check to see if the receiver is receiving
PCM."),nl,
      write("3. Check the TD-754 to see if it is receiving
PCM if there"),nl,
      write("is a cable system."),nl,
      write("4. Ensure the system is patched properly."),nl,
      write("5. Loop back the TD-660 to see if the TD-660
will work in"),nl,
      write("the van and then have the distant end loop back
from their"),nl,
      write("TD-660 to see if it will work from there."),nl,
      write(". Ensure the distant end TD-660 is sending
PCM/Timing."),nl,
      write("7. Replace the TD-660 at the end having
problems."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(cv1548_power_indicator_trouble):-
      write("\n\n\tActions to Solve CV-1548 Power Indicator
Problem"),nl,
      write(". Check for proper power at the main power
panel indicator."),nl,
      write(". If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write(". Replace power cables if connectors are bad
or cable is frayed."),nl,
      write(". Replace power indicator lamp if bulb is
burned out."),nl,
      write(". Check fuses."),nl,
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      write("6. Replace CV-1548 if all other actions
fail."),nl,
      write("7. Contact electronic maintenance support for
assistance.\n").

    resp(cv1548_20Hz_drive_trouble):-
      write("\n\n\tActions to Solve CV-1548 20 Hz Drive
Problem"),nl,nl,
      write("1. Adjust the 20 Hz drive on the CV-1548/G
model only."),nl,
      write("2. Check fuses."),nl,
      write("3. Check the 18A2 card and replace it if it is
defective."),nl,
      write("4. Replace the CV-1548 at the end having
problems."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(cv1548_ringer_card_trouble):-
      write("\n\n\tActions to Solve CV-1548 Ringer Card
Problem"),nl,nl,
      write("1. Check fuses on the CV-1548."),nl,
      write("2. Ensure the 18A3B CCA converts 20Hz to
1600Hz."),nl,
      write("3. Ensure the 18A3B CCA converts 1600Hz to
20Hz."),nl,
      write("4. Replace defective CCA."),nl,
      write("5. Pressing the test switch(1600Hz to 20Hz) is
not a true"),nl,
      write("test.  Phone to phone is the only true
test."),nl,
      write("6. Replace the CV-1548 at the end having
problems."),nl,
      write("7. Contact electronic maintenance support for
assistance.\n").

    resp(td1065_power_indicator_trouble):-
      write("\n\n\tActions to Solve TD-1065 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Check TD-1065 fuses."),nl,
      write("6. Reset the circuit breaker."),nl.
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```
      write("7. Replace TD-1065 if all other actions
fail."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(td1065_voltage_level_trouble):-
      write("\n\n\tActions to Solve TD-1065 Voltage Level
Problem"),nl,nl,
      write("1. Ensure the voltage level is a +10 or -10
with a green light."),nl,
      write("2. Replace the TD-1065 at the end having
problems."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").

    resp(td1065_transmitter_receiver_trouble):-
      write("\n\n\tActions to Solve TD-1065 Transmitter
Receiver Problem"),nl,nl,
      write("1. Adjust the transmitter/receiver indicator or
replace it"),nl,
      write("if it is defective."),nl,
      write("2. Replace the TD-1065 at the end having
problems."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").

    resp(td1065_communications_channel_trouble):-
      write("\n\n\tActions to Solve TD-1065
Communications/Channel Problem"),nl,nl,
      write("1. Check the communications/channel LED or
replace it"),nl,
      write("if it is defective."),nl,
      write("2. Ensure the LED alarm is not caused by noise
from the"),nl,
      write("TD-754, TD-660 or TD-1069."),nl,
      write("3. Replace the TD-1065 at the end having
problems."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td1069_power_indicator_trouble):-
      write("\n\n\tActions to Solve TD-1069 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
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      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Check TD-1069 fuses."),nl,
      write("6. Reset the circuit breaker."),nl,
      write("7. Replace TD-1069 if all other actions
fail."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(td1069_DC_output_trouble):-
      write("\n\n\tActions to Solve TD-1069 DC Output Level
Problem"),nl,nl,
      write("1. Turn off the AC power switch on the TD-
1069."),nl,
      write("2. Observe DC power indicator while turning
back on AC power."),nl,
      write("3. If lamp lights for an instant but goes back
out, then the"),nl,
      write("lamp is good but one of the following
conditions are present:"),nl,
      write("\ta. No DC output."),nl,
      write("\tb. Current overload."),nl,
      write("\tc. Internal temperature is too high."),nl,
      write("4. Replace the TD-1069 at the end having
problems."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(td1069_rate_function_traffic_alarms_trouble):-
      write("\n\nActions to Solve TD-1069
Rate/Function/Traffic Alarms Problem"),nl,nl,
      write("1. Check the rate/function/traffic alarms
indicator and replace"),nl,
      write("it if it is defective."),nl,
      write("2. Ensure operator did not press the assign
switch after changing"),nl,
      write("the switch setting."),nl,
      write("3. Check for rate alarm caused by improper rate
switch settings."),nl,
      write("4. Check for function alarm caused by rate
switch settings.  This"),nl,
      write("is often caused by noise in system which causes
one end to change"),nl,
      write("memory which in turn causes function
alarm."),nl,
      write("5. Traffic alarm (steady) is always caused by
the absence of a"),nl,
      write("receive 32KBs signal."),nl,
      write("6. Traffic alarm (blinking) is normally caused
by noise in the system."),nl,
      write("The problem is usually at the end with the
blinking light."),nl,
```

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      write("7. Replace the TD-1069 at the end having
problems."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(td1069_port_settings_trouble):-
      write("\n\n\tActions to Solve TD-1069 Port Settings
Problem"),nl,nl,
      write("1. Adjust the port rate mode switch."),nl,
      write("2. If the TD-1069s at both ends have the same
port settings"),nl,
      write("and both ends were assigned then higher level
maintenance is"),nl,
      write("required."),nl,
      write("3. Replace the TD-1069 first at the end having
problems and"),nl,
      write("then at the other end."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td1069_assign_settings_trouble):-
      write("\n\n\tActions to Solve TD-1069 Assignment
Settings Problem"),nl,nl,
      write("1. Adjust the assignment rate mode
switch."),nl,
      write("2. If the TD-1069s at both ends have the same
assignment"),nl,
      write("settings and port settings then higher level
maintenance is"),nl,
      write("required."),nl,
      write("3. Replace the TD-1069 first at the end having
problems and"),nl,
      write("then at the other end."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(kg27_power_indicator_trouble):-
      write("\n\n\tActions to Solve KG-27 Power Indicator
Problem"),nl,nl,
      write("1. Check for proper power at the main power
panel indicator."),nl,
      write("2. If main van power indicator shows acceptable
power, then"),nl,
      write("ensure power cables are properly
connected."),nl,
      write("3. Replace power cables if connectors are bad
or cable is frayed."),nl,
      write("4. Replace power indicator lamp if bulb is
burned out."),nl,
      write("5. Check KG-27 fuses."),nl,
      write("6. Reset the circuit breaker."),nl,
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      write("7. Replace KG-27 if all other actions
fail."),nl,
      write("8. Contact cryptographic maintenance support
for assistance.\n").

    resp(kg27_keylist_trouble):-
      write("\n\n\tActions to Solve KG-27 Keylist Mismatch
Problem"),nl,nl,
      write("1. Verify that each end of the system is
operating on the"),nl,
      write("correct day of the same keylist version."),nl,
      write("2. Have each multichannel operator recheck
their KOK keylist"),nl,
      write("settings against the verified keylist."),nl,
      write("3. Ensure a stylus is used to properly set the
KOK cards and"),nl,
      write("the vertical number indicator is properly
seated in the correct"),nl,
      write("numbered position according to the
keylist."),nl,
      write("4. Do an in-house system check to a second
stack of equipment ensuring"),nl,
      write("it frares up quiet prior to putting it in
system."),nl,
      write("5. Replace KG-27 if all other actions
fail."),nl,
      write("6. Contact cryptographic maintenance support
for assistance.\n").

    resp(datasb_system_switch_trouble):-
      write("\n\n\tActions to Solve Data Switch Box System
Switch Problem"),nl,nl,
      write("1. Adjust the data switch box system switch or
replace it"),nl,
      write("if it is defective."),nl,
      write("2. If switch box is bad use the alternate
system."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").

    resp(datasb_audio_data_switch_trouble):-
      write("\n\n\tActions to Solve Data Switch Box
Audio/Data Switch Problem"),nl,nl,
      write("1. Adjust the data switch box audio/data switch
or replace it"),nl,
      write("if it is defective."),nl,
      write("2. If switch box is bad use the alternate
system."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").
```

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    resp(video_proper_connections_trouble):-
      write("\r\nActions to Solve Video Int/Binding Post
Connections Problem"),nl,nl,
      write("1. Ensure the CNCE indicates no commo over all
the circuits."),nl,
      write("2. Ensure operator can talk over channels to
distant operator."),nl,
      write("3. Ensure operator can not talk to the patch
panel."),nl,
      write("4. Ensure the cables are hocked to the proper
signal entrance"),nl,
      write("hock matching the stack with the installed
system."),nl,
      write("5. Ensure the cables are secured tightly to the
hock."),nl,
      write("6. Ensure the cable hock has not been damaged
or have any bent"),nl,
      write("broken or wet connectors."),nl,
      write("7. Ensure the binding post is in the proper
position for cable"),nl,
      write("or wire depending on which is connected."),nl,
      write("8. Replace any defective parts."),nl,
      write("9. Contact electronic maintenance support for
assistance.\n").

    resp(video_proper_channel_trouble):-
      write("\n\n\tActions to Solve Video Int/Binding Post
Channel Problem"),nl,nl,
      write("1. Ensure the wire is hooked to the proper
channel connectors"),nl,
      write("which match the circuit routing list."),nl,
      write("2. Ensure two wire circuits are hooked to the
Xmit/Rec pair for"),nl,
      write("the channel.\n"),
      write("3. For 4 wire circuit using WF-16 wire, ensure
that the reddish"),nl,
      write("brown pair is connected to the REC side and the
green pair to XMT."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    /* Response To Circuit Problems Section */

    resp(site_circuit_path):-
      write("\n\n\tActions to Solve Site Circuit Path
Problem"),nl,nl,
      write("1. Ensure 26 pair cable or PCM cable is
properly connected"),nl,
      write("to both vans that have the interconnection
problem."),nl,
      write("2. Have a cable team check for continuity of
the cable and wire."),nl,
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      write("3. Conduct a signal level meter test with the
cable from"),nl,
      write("the patch panel or a portable meter."),nl,
      write("4. Check cable connectors for damage or
moisture"),nl,
      write("5. Replace the defective cable or wiring if
necessary.\n").


    resp(site_patch_panel_circuit_wiring):-
      write("1. Check for proper 26 pair cable or wire
connections to van."),nl,
      write("2. Ensure wire and cable are good by using
signal meter test."),nl,
      write("3. Ensure proper patch cord connections per
circuit routing lists."),nl,
      write("4. Check for good patch cords with signal
meter."),nl,
      write("5. Clean patch cord ends and patch holes with
polishing cloth"),nl,
      write("or proper cleaning solution."),nl,
      write("6. Replace any defective equipment."),nl,
      write("7. Ensure the switchboard is using the correct
impedance headset."),nl,
      write("8. Contact electronic maintenance support for
assistance.\n").

    resp(multichannel_circuit_wiring_trouble):-
      write("\n\n\tActions to Solve Multichannel Circuit
Wiring Problem"),nl,nl,
      write("1. Verify all wires are hooked to the proper
piece of equipment"),nl,
      write("in the proper position."),nl,
      write("2. Ensure continuity of the wiring and inspect
for damage."),nl,
      write("3. Replace defective wiring and put tested
cabling back in the"),nl,
      write("signal duct as soon as possible."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(td660_switch_setting_trouble):-
      write("\n\n\tActions to Solve TD-660 Switch Setting
Problem"),nl,nl,
      write("1. Ensure the 2W/4W switches and all other
switch settings"),nl,
      write("on the TD-660 are according to the TM and
CRL's."),nl,
      write("2. Check for a defective 11A26 card."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").
```

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    resp(td660_channel_alignment_trouble):-
      write("\n\n\tActions to Solve TD-660 Channel Alignment
Problem"),nl,nl,
      write("1. Have each multichannel operator send tone
while the other"),nl,
      write("operator adjusts the alignment on the TD-660 to
the proper"),nl,
      write("level depending on the type of circuit to be
installed on"),nl,
      write("that particular channel, the TM and the unit
Field SOP."),nl,
      write("2. TD-660's should be periodically aligned
using test equipment"),nl,
      write("on the bench at the unit electronic maintenance
facility."),nl,
      write("3. TD-660's which cannot be aligned properly
should be replaced."),nl,
      write("4. Ensure that all TD-660s are using high
series CCAs such as"),nl,
      write("11A25, 11A26, 11A27 etc.  If low series are
used there will be"),nl,
      write("problems making trunk calls."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(td660_channel_card_trouble):-
      write("\n\n\tActions to Solve TD-660 Channel Card
Problem"),nl,nl,
      write("1. TD-660 channel cards unable to be aligned or
adjusted"),nl,
      write("should be replaced."),nl,
      write("2. TD-660 channel cards with visible damage or
not working"),nl,
      write("properly should be replaced."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").

    resp(cv1548_switch_setting_trouble):-
      write("\n\n\tActions to Solve CV-1548 Switch Setting
Problem"),nl,nl,
      write("1. Ensure the 2W/4W switches and all other
switch settings"),nl,
      write("on the CV-1548 are according to the TM and
CRL's."),nl,
      write("2. Replace broken switches as necessary."),nl,
      write("3. Contact electronic maintenance support for
assistance.\n").
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    resp(cv1548_circuit_ringer_card_trouble):-
      write("\n\n\tActions to Solve CV-1548 Ringer Card
Problem"),nl,nl,
      write("1. Ensure 18A3B circuits can properly ring
through in the"),nl,
      write("2W AC mode."),nl,
      write("2. Ensure 18A3B cards converts 20 Hz to 1600 Hz
and 1600Hz"),nl,
      write("to 20Hz signals."),nl,
      write("3. Ensure circuit path continuity is not
interrupted on a"),nl,
      write("four wire circuit."),nl,
      write("4. Replace defective ringer cards as
necessary."),nl,
      write("5. Contact electronic maintenance support for
assistance.\n").

    resp(ttc41_database_trouble):-
      write("\n\n\tActions to Solve TTC-41 database
Problem"),nl,nl,
      write("1. Obtain a printout of the TTC-41 database
from memory."),nl,
      write("2. Match the memory database against the
operators worksheet"),nl,
      write("prepared in conjunction with the Circuit
Routing Lists."),nl,
      write("3. Make any corrections to the memory versions
of the database"),nl,
      write("to ensure accuracy."),nl,
      write("4. Do not allow operator corrections to the
database based on"),nl,
      write("customer requests without prior approval from
SYSCON."),nl,
      write("5. Ensure batteries on the memory cards have
the appropriate"),nl,
      write("voltage level or memory will decay and the
database will act"),nl,
      write("in an erratic manner."),nl,
      write("6. Replace defective memory cards or weak
batteries as needed."),nl,
      write("7. Contact electronic maintenance support for
assistance.\n").

    resp(ttc41_central_processing_unit_trouble):-
      write("\n\n\tActions to Solve TTC-41 CPU
Problem"),nl,nl,
      write("1. Ensure all function checks can be performed
on the CPU."),nl,
      write("2. Ensure the proper printouts are obtained
when accessing"),nl,
      write("the CPU's RAM."),nl,
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      write("3. Follow the appropriate troubleshooting guide
in the TM."),nl,
      write("4. Contact electronic maintenance support for
assistance.\n").

    resp(ttc41_patch_panel_wiring_trouble):-
      write("\n\n\tActions to Solve TTC-41 Patch Panel
Wiring Problem"),nl,nl,
      write("1. Ensure patch cords are properly tested for
continuity"),nl,
      write("with a signal meter prior to use."),nl,
      write("2. Ensure patch cords have been placed in the
proper female") nl,
      write("patch hole according to the CRC's and the
operators worksheet."),nl,
      write("3. Contact operations personnel for
assistance.\n").

    resp(ttc41_subscriber_equipment_trouble):-
      write("\n\n\t\tTelephone Set Repair Actions"),nl,nl,
      write("A. Telephone Sets TA-43/PT and TA-312/PT"),nl,
      write("\t1. Ensure Handset/Receiver is fully on hook
in the"),nl,
      write("retaining cradle and seated on the
connector."),nl,
      write("\t2. Check the binding post to ensure proper
transmission"),nl,
      write("line connection."),nl,
      write("\t3. Ensure LOUD/LOW control is not set too
low.  Fully"),nl,
      write("clockwise is maximum loud position."),nl,
      write("\t4. Replace batteries."),nl,
      write("\t5. Replace telephone if necessary."),nl,
      write("B. Telephone Set TA-341/TT"),nl,
      write("\t1. Ensure receiver is on hook."),nl,
      write("\t2. Ensure battery door is closed
securely."),nl,
      write("\t3. Ensure all wires are properly
connected."),nl,
      write("\t4. Check bottom of phone to ensure operating
mode is correct."),nl,
      write("\t5. Replace batteries."),nl,
      write("\t6. Replace telephone if necessary."),nl,
      readchar(_),
      write("C. Telephone Set TA-838/TT"),nl,
      write("\t1. Ensure Handset/Receiver is fully on hook
in the"),nl,
      write("retaining cradle and seated on the
connector."),nl,
      write("\t2. Check the binding post to ensure proper
transmission"),nl,
      write("line connection."),nl,
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      write("\t3. Ensure LOUD/LOW control is not set too
low.  Fully"),nl,
      write("clockwise is maximum loud position."),nl,
      write("\t4. Ensure battery door is closed
securely."),nl,
      write("\t5. Replace batteries."),nl,
      write("\t6. Replace telephone if necessary."),nl,
      write("D. Telephone Sets TA-938/G and TA-236/FT"),nl,
      write("\t1. Ensure the receiver is fully on
hook."),nl,
      write("\t2. Ensure all wires are properly
connected."),nl,nl,
      readchar(_),
      write("\t\tFacsimile Set Repair Actions"),nl,nl,
      write("1. Follow printed manufacturer's
troubleshooting instructions."),nl,
      write("2. Ensure proper paper type is being
used."),nl,
      write("3. Ensure paper is not wet or damaged."),nl,
      write("4. Check for possible paper jams in the
machine."),nl,
      write("5. Check for machine toner and developer levels
if appropriate."),nl,
      write("6. Ensure telephone line is properly connected
and operational."),nl,
      write("Check the telephone line with a regular
telephone back to the"),nl,
      write("switchboard."),nl,
      write("7. Ensure machine settings are all
correct.\n"),
      readchar(_).

  /* Site Installation Guide User Interface */

  resp(site_arrival):-
    write("\n\tA Multichannel Communications Site
Installation Guide"),nl,nl,
    write("1.  SITE ARRIVAL:"),nl,
    write("\ta. Clearance and Reconnaissance."),nl
    write("\t\t(1) Recon and clear site for mines and
NBC."),nl,
    write("\t\t(2) Post security personnel."),nl,
    write("\tb. Plan Site area:"),nl,
    write("\t\t(1) Position vehicles:"),nl,
    write("\t\t\t(a) Shelters level."),nl,
    write("\t\t\t(b) Shelters will be placed using minimum
cable."),nl,
    write("\t\t(2) Position generators:"),nl,
    write("\t\t\t(a) Generators level."),nl,
    write("\t\t\t(b) Generators grounded IAW SOP."),nl,
    write("\t\t\t(c) All power cables buried."),nl,
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    write("\t\t\t(d) If commercial power is available, check
to ensure"),nl,
    write("power is correct and properly grounded."),nl,
    write("\t\t(3) Position POL:"),nl,
    write("\t\t\t(a) POL placed a minimum of 50 feet from
vans and"),nl,
    write("generators."),nl,
    write("\t\t\t(b) No smoking sign posted."),nl,
    write("\t\t\t(c) Fire point set up between vans and
generators."),nl,
    write("\t\t\t(d) Fuel containers capped and gaskets in
place."),nl,
    write("\t\t\t(e) Fuel can adapters utilized."),nl,
    write("\t\t\t(f) No mogas for stoves.  Stove pipes
cleaned daily."),nl,nl,
    readchar(_),
    write("2. ANTENNAS:"),nl,
    write("\ta. Position antennas so correct azimuth will
not cross"),nl,
    write("generators and is clear of obstacles to include
other antennas."),nl,
    write("Ensure signal paths DO NOT CROSS."),nl,
    write("\tb. Check wattage output at the end of the
antenna."),nl,
    write("\tc. Ensure antenna is on correct
polarization."),nl,
    write("\td. Ensure correct elevation/deflection on
antenna."),nl,
    write("\te. Ensure coax has a tight connection and is
taped at antenna."),nl,
    write("\tf. Ensure coax has a stress loop."),nl,
    write("\tg. Ensure coax is secure to mast at the top and
just above the"),nl,
    write("launcher."),nl,
    write("\th. Ensure antenna is on proper azimuth."),nl,
    write("\ti. Ensure antenna is guyed IAW TM and
SOP."),nl,
    write("\tj. Ensure antenna guy tension is checked twice
daily."),nl,
    write("\tk. Ensure coax is secured to van with drip loop
and separated"),nl,
    write("from power cable, 26 pair, and PCM
cable."),nl,nl,
    readchar(_).

  resp(multichannel_site):-
    write("3. PROCEDURE FOR INSTALLING MULTICHANNEL
COMMO:"),nl,
    write("\ta. Perform preoperational checks on generators
IAW TM."),nl,
    write("\tb. Perform preoperational checks on commo
equipment IAW"),nl,
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    write("TM (Ensure circuit breaker off before power
applied to van)."),nl,
    write("\tc. Establish commo on engineering frequency
(VRC-46 or GRC-106)."),nl,
    write("\td. Perform radio loop test (tropo receiver
alignment)."),nl,
    write("\te. Tune radio to assign frequency IAW TM."),nl,
    write("\tf. Establish orderwire communications."),nl,
    write("\tg. Orient antenna for highest receive signal
(both azimuth"),nl,
    write("and height)."),nl,
    write("\th. Perform radio to radio system alignment IAW
TM."),nl,
    write("\ti. Connect PCM to system and perform orderwire
alignment"),nl,
    write("using tone IAW TM."),nl,
    readchar(_),
    write("\tj. Set CV1548 IAW CRL and TM."),nl,
    write("\tk. Align channels on MUX to hairline using
tone."),nl,
    write("\tl. Ensure power cable, 26pr cable, PCM cable
and coax do"),nl,
    write("not cross."),nl,
    write("\tm. All back up radio equipment will be aligned
to assigned"),nl,
    write("frequency on dummy load."),nl,
    write("\tn. All back up MUX equipment will be secure on
current key"),nl,
    write("list and hot."),nl,
    write("\to. All back up cable will be connected to a hot
back up stack."),nl,
    write("\tp. MINIMUM receive sig. for VHF system 20 and
UHF 10."),nl,
    write("\tq. MAXIMUM power out for VHF 30 and UHF
20."),nl,
    write("\tr. MAXIMUM Reflective power for VHF 10 and UHF
10."),nl,
    write("\ts. Daily 2404 will be kept in van IAW TM."),nl,
    write("\tt. Did you read Bn. TAC SOP?"),nl,nl,
    readchar(_).

  resp(general_site1):-
    write("\tA General Site Installation Guide"),nl,nl,
    write("1.  INITIAL PREPARATIONS:"),nl,
    write("\ta. Ensure that all required maps are on
hand."),nl,
    write("\tb. Map reconnaissance of route to site."),nl,
    write("\tc. Map reconnaissance of site."),nl,
    write("\td. Check vehicles; complete, operational."),nl,
    write("\te. Check signal equipment; complete,
operational."),nl,
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    write("\tf. Check generators; complete,
operational."),nl,
    write("\tg. Check POL (Basic load for initial 72
hours)."),nl,
    write("\th. Check tents and cots for
serviceability."),nl,
    write("\ti. Check stoves, pipes, for serviceability, and
diesel"),nl,
    write("fuel supply."),nl,
    write("\tj. Check water and rations."),nl,
    write("\tk. Personal field equipment.(TA-50)"),nl,
    write("\tl. Individual and crew served weapons."),nl,
    write("\tm. Personal comfort items; first aid kit;
toilet paper, etc."),nl,
    write("\tn. NBC equipment; complete, operational."),nl,
    write("\to. TM for van and generator on hand in
van."),nl,
    write("\tp. Check to ensure correct COMSEC material
issued."),nl,nl,
    readchar(_),
    write("2.  MOVE OUT PREPARATION:"),nl,
    write("\ta. Brief team members:"),nl,
    write("\t\t(1) Security to include EEFI."),nl,
    write("\t\t(2) Correct Site location."),nl,
    write("\t\t(3) Route to site, to include
checkpoints."),nl,
    write("\t\t(4) Duties before, enroute, and upon arrival
at site."),nl,
    write("\t\t(5) Convoy briefing; speed; anticipated
stops, etc."),nl,
    write("\t\t(6) Safety briefing."),nl,
    write("\t\t(7) Wearing of proper uniform at all
times."),nl,
    write("\tb. Inspect:"),nl,
    write("\t\t(1) Equipment loaded by loading plan, secure,
etc."),nl,
    write("\t\t(2) Check vehicles; lights; brakes;
etc."),nl,nl,
    readchar(_).

  resp(general_site2):-
    write("3.  RATT/FM:"),nl,
    write("\ta. The following items will be in each RATT/FM
rig:"),nl,
    write("\t\t(1) DD Form 1578 present and filled out
properly."),nl,
    write("\t\t(2) DA Form 2653-R present and being
used."),nl,
    write("\t\t(3) Wave propagation charts are
present."),nl,
    write("\t\t(4) Have a net diagram posted in each
van."),nl,
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    write("\t\t(5) Post all messages from Commanders on the
wall."),nl,
    write("\tb. The items listed below will be done at each
RATT/FM site:"),nl,
    write("\t\t(1) A doublet antenna will be erected on each
site within"),nl,
    write("3 hours after arrival. (RATT ONLY)"),nl,
    write("\t\t(2) An RC-292 will be installed one hour
after arrival"),nl,
    write("on site. (FM ONLY)"),nl,
    write("\t\t(3) ME-165 being used and a minimum SWR
achieved. (RATT ONLY)"),nl,
    write("\t\t(4) The height of the doublet antenna will be
in"),nl,
    write("accordance with the wave propagation charts
issued by the S-3."),nl,
    write("\t\t(5) All sub-stations will have their spare RT
set."),nl,
    write("\t\t(6) All FM radios to be checked with a PRM-
34."),nl,
    write("\t\t(7) Remote FM radios to customers."),nl,
    write("\t\t(8) RC-292s using the correct number of
elements for"),nl,
    write("the frequency used."),nl,nl,
    readchar(_),
    write("4. POSITION LIVING AREA.(covered and concealed if
possible)"),nl,nl,
    write("5. POSITION LATRINE. (downhill from living
area)"),nl,nl,
    write("6. SITE DEFENSE:  (posted in van)"),nl,
    write("\ta. Prepare defensive positions."),nl,
    write("\tb. Position machine guns and grenade launchers
at most"),nl,
    write("likely enemy avenues of approach."),nl,
    write("\tc. Ensure each team member has a planned
defensive position."),nl,
    write("\td. Ensure each position has a range
card."),nl,nl,
    readchar(_).

  resp(general_site3):-
    write("7. SITE PLAN: Sr NCOIC/Site Chief is responsible
for everything"),nl,
    write("on his site."),nl,
    write("\ta. Each site chief has a drawn site plan
consisting of:"),nl,
    write("\t\t(1) Site entrance(s) and exit(s)."),nl,
    write("\t\t(2) Vehicle location (admin vehicle in
separate area)."),nl,
    write("\t\t(3) Tent location(s)."),nl,
    write("\t\t(4) Latrine locations."),nl,
    write("\t\t(5) POL Locations."),nl,
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    write("\t\t(6) Fire point locations."),nl,
    write("\t\t(7) Helipad location."),nl,
    write("\t\t(8) Defensive positions."),nl,
    write("\t\t(9) Site briefing (for visitors)."),nl
    write("\tb. Mission:"),nl,
    write("\t\t(1) Mission (bubble chart, 5x8 card, CRL, and
residual"),nl,
    write("chart posted inside van)."),nl,
    write("\t\t(2) Status: systems operational, number of
circuits"),nl,
    write("installed and operational."),nl,
    write("\t\t(3) Maintenance (motor, generator, and CE
operator dailies)."),nl,
    write("\t\t(4) Personnel (numbers assigned, on duty,
location)."),nl,
    write("\t\t(5) Power source (generator, type/size, or
commercial)."),nl,
    write("\t\t(6) Support (POL, BEMS, COMSEC, and/or
billets provided by)."),nl,
    write("\t\t(7) Reporting procedures."),nl,nl,
    readchar(_),
    write("8. SITE CLOSE OUT:"),nl,
    write("\ta. Terminate communications, except FM."),nl,
    write("\tb. Load equipment IAW loading plan."),nl,
    write("\tc. Recover cable/wire lines."),nl,
    write("\td. Load POL."),nl,
    write("\te. Police area and fill in latrines."),nl,
    write("\tf. Brief personnel: driver safety, etc.\n").
```

APPENDIX B: Program Question List

#	Codeword	Question
1.	(problem)	Do you have a problem you need assistance with somewhere in the Division communications system?
2.	(site)	Does the problem affect all the multichannel communications systems on a site?
3.	(profile)	Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
4.	(power)	Has all contact to the communications site been suddenly lost on all systems?
5.	(emp)	Has there been a nuclear explosion in the vicinity of the affected site?
6.	(system)	Does the problem affect all the channels on a particular system?
7.	(syspwr)	Once the system was properly established, was all contact suddenly lost?
8.	(syspro)	Have the multichannel operators been able to get good loopbacks from another location?
9.	(syscbl)	Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
10.	(sysrfi)	Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
11.	(sysptch)	Does the patch panel operator receive a good signal but the switchboard operator does not?
12.	(sysmult)	Is the multichannel operator unable to establish a good multichannel system?
13.	(sysmultant)	Does the multichannel operator get a high reflect power from the antenna system?

14. (sysmultrdo) Does the multichannel operator obtain a low received signal on the receiver or a low power out on the transmitter?

15. (rt773) Does the orderwire not function properly for the radio?

16. (pwrind773) Does the power indicator light on the RT-773 not work?

17. (tone773) Is the multichannel operator unable to detect a 1600 Hz tone over the system?

18. (contact773) Can the multichannel operator not make orderwire contact over the radio system once good residuals are obtained?

19. (r1329) Does the radio receiver not function properly?

20. (pwrind1329) Does the power indicator light on the R-1329 not work?

21. (volt1329) Does the multichannel operator have improper voltage level readings on the R-1329?

22. (sigind1329) Does the multichannel operator have improper signal level readings on the R-1329?

23. (pcm1329) Is the multichannel operator unable to obtain 12 channel PCM on the R-1329?

24. (t983) Does the radio transmitter not function properly?

25. (pwrind983) Does the power indicator light on the T-983 not work?

26. (volt983) Does the multichannel operator have improper voltage level readings on the T-983?

27. (pwrsig983) Does the multichannel operator have improper signal level readings on the T-983?

28. (pcm983) Is the multichannel operator unable to obtain 12 channel PCM on the T-983?

29. (sysmultmux) Is the multichannel operator unable to get the channels to frame up or the channels are noisy?

30. (td754) Does the TD-754/204 appear to be not mixing the multiplexed signals into a bit stream to be passed on the cable system?

31. (pwrind754) Does the power indicator light on the TD-754/204 not work?

32. (volt754) Does the multichannel operator have improper voltage level readings on the TD-754/204?

33. (mile754) Does the multichannel operator have improper mileage settings on the TD-754/204?

34. (alph754) Does the multichannel operator have improper alphabet indications on the TD-754/204?

35. (pcm754) Does the multichannel operator obtain improper levels for PCM in/Timing in on the TD-754/204?

36. (td660) Is the multichannel operator unable to talk off of the handset on the TD-660 channels and does the TD-660 appear to be not functioning properly?

37. (pwrind660) Does the power indicator light on the TD-660 not work?

38. (volt660) Does the multichannel operator have improper voltage level readings on the TD-660?

39. (alph660) Does the multichannel operator have improper readings on the TD-660 alphabet settings?

40. (noise660) Does the noise generator on the TD-660 not work properly?

41. (osc660) Does the oscillator on the TD-660 not function properly?

42. (pcm660) Does the multichannel operator obtain improper levels for PCM in/Timing in on the TD-660?

43. (cv1548) Do the CV-1548 ringer cards not convert signals or ring properly?

44. (pwrind1548) Does the power indicator light on the CV-1548 not work?

45. (dr154820Hz) Does the 20 Hz drive on the CV-1548 not function properly?

46. (card154818A3B) Is the multichannel operator unable to get the 18A3B ringer cards on the CV-1548 to light and ring on AC mode?

47. (td1065) Is the TD-1065 multiplexor not functioning properly?

48. (pwrind1065) Does the power indicator light on the TD-1065 not work?

49. (volt1065) Does the multichannel operator have improper voltage level lights on the TD-1065?

50. (xtmrec1065) Does the multichannel operator have improper lights on the TD-1065 transmitter/receiver indicator?

51. (comchan1065) Does the multichannel operator have improper lights on the TD-1065 communications/channel indicator?

52. (td1069) Is the TD-1069 multiplexor not functioning properly?

53. (pwrind1069) Does the power indicator light on the TD-1069 not work?

54. (dcout1069) Does the multichannel operator obtain improper DC output lights on the TD-1069?

55. (rate1069) Does the multichannel operator obtain improper lights on the TD-1069 rate/function/traffic alarms?

56. (port1069) Does the multichannel operator have improper port settings on the TD-1069?

57. (assign1069) Does the multichannel operator have improper assignment settings on the TD-1069?

58. (sysmultcry) Does the multichannel operator have timing hits or a rushing noise on the channels and is unable to get a good loopback?

59. (kgpwrind) Does the power indicator light on the KG-27 not work?

60. (kgkey) Has the multichannel operator improperly set the keylist on the KOK cards and been unable to get a good loopback inhouse or from a distant site?

61. (sysmultwire) Does there appear to be a circuit path problem on the TRC-145 making it impossible to go beyond the CV-1548?

62. (dataswbox) Does the multichannel operator have a good signal path up to the data switch box but not to the binding posts?

63. (dsbsyssw) Is the system switch on the data switch box in the incorrect position or not functioning properly?

64. (dsbaudio) Is the audio/data switch on the data switch box in the incorrect position or not functioning properly?

65. (video) Does the multichannel operator have a good signal path before the video interconnect/binding post box?

66. (vidcon) Have there been improper connections made to the signal entrance box with 26 pair cable or wire?

67. (vidchan) Have the channels been improperly set on the binding post box or connected on the incorrect terminals?

68. (circuit) Does the problem affect only specific circuits on a system?

69. (circbl) Does the multichannel operator have a good circuit path to the distant system end, but the next local operator in the circuit path cannot receive an adequate signal?

70. (cirptch) Does the patch panel operator have a good circuit path to the other end, but the switchboard operator cannot receive an adequate signal?

71. (cirmult) Does the circuit path stop at the multichannel system?

72. (cirwr) Can the multichannel operator talk to the subscriber off of the binding posts but not from the TD-660 or CV-1548?

73. (cirmux) Do other circuits work through the multichannel multiplexing equipment but not specific channels?

74. (cir660) Is the multichannel operator unable to talk off of the handset on the TD-660 for the specific channel?

75. (cir660swset) Does the circuit appear to only be working one direction?

76. (cir660chanalign) Does the circuit have some distortion or only works with certain types of circuits?

77. (cir660chancard) Does the circuit path stop at the TD-660 but continues once the channel card is changed?

78. (cir1548) Do the CV-1548 ringer cards not convert signals or ring properly?

79. (cir1548swset) Does the circuit only work in one mode?

80. (cir1548rngcard) Is the circuit path good to the CV-1548 but not beyond or does not ring in the AC mode?

81. (cir41) Is the switchboard a TTC-41?

82. (cir41data) Does the problem circuit not have the proper features or is not operating once a circuit path has been established?

83. (cir41cpu) Do the switchboard circuits not work or sporadic problems are occurring like ghost rings or calls dropping off?

84. (cir41ptch) Does the incoming signal make it to the switchboard's patch panel but not to the CPU?

85. (cir41subeq) Does the subscriber's circuit work from the users junction box with similar test equipment but not with the subcriber's equipment?

86. (siteinst) Would you like a printout of the steps to properly install a communications site?

87. (changes) Would you like to make changes to the answers provided above by starting over and making the correct entry?

APPENDIX C: Typical Program Output
C.1: Site Problems

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
yes
Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a line of sight profile.

Actions to Solve Line of Sight Problem

1. Corduct a map reconnaissance to locate a higher site that all multichannel systems can reach.
2. Contact higher level signal planning element for assistance in conducting computer assisted profiling.
3. Relocate communications site to new location and establish communications with all locations.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
yes
Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
no
Has all contact to the communications site been suddenly lost on all systems?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a site power outage.

Actions to Solve Site Power Outage

1. Have all systems with back up power switch to that power source until the site central power can be restored.
2. Ensure central power circuit breakers are off prior to attempting repair actions.
3. Ensure fuel level is adequate in set tanks or external tanks.
4. Check fuel filters for cleanliness and serviceability.
5. Check oil levels and overall serviceability of generator.
6. Ensure frequency and voltage levels are correct prior to reconnecting power cables and flipping the circuit breaker.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
yes
Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Has there been a nuclear explosion in the vicinity of the affected site?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be an electromagnetic pulse destroyed circuitry.

Actions to Solve EMP Destroyed Equipment

1. Replace damaged power cables and signal cables.
2. Replace damaged antennas.
3. Bring up back-up equipment on-line.
4. Establish communications using RATT rig or AM voice first.
5. Reestablish multichannel communications after coordination with distant sites.

Please press the space bar to exit

C.2: System Problems

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a system power outage.

Actions to Solve System Power Outage

1. Turn off main circuit breaker on van power panel.
2. Check for damaged power cable.
3. Ensure circuit breakers are operating properly.
4. Switch to back-up generator if available.
5. Check fuel and oil levels in out of service generator.
6. Check fuel filters for cleanliness and serviceability.
7. Check for overall serviceability of generator.
8. Ensure frequency and voltage levels are correct prior to flipping the circuit breaker.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
no
Have the multichannel operators been able to get good loopbacks from another location?
no
Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
no
Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
no
Does the patch panel operator receive a good signal but the switchboard operator does not?
no
Is the multichannel operator unable to establish a good multichannel system?
yes
Does the multichannel operator get a high reflect power from the antenna system?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be with a system multichannel antenna.

Actions to Solve Multichannel Antenna Problem

1. Switch to a back-up antenna system if available.
2. Lower antenna and check coax cable with the dummy load at the end of the cable for reflect power readings. If the readings are poor then replace the coax cable until good reflect power readings are established.
3. If coax cable is good then check the antenna connections for water or damage to the antenna. Replace an antenna if it has been damaged or good reflect readings cannot be obtained once the coax cable has been checked good.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
no
Have the multichannel operators been able to get good loopbacks from another location?
no
Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
no
Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
no
Does the patch panel operator receive a good signal but the switchboard operator does not?
no
Is the multichannel operator unable to establish a good multichannel system?
yes
Does the multichannel operator get a high reflect power from the antenna system?
no
Does the multichannel operator obtain a low received signal on the receiver or a low power out on the transmitter?
no

Is the multichannel operator unable to get the channels to frame up or the channels are noisy?
yes
Does the TD-754/204 appear to be not mixing the multiplexed signals into a bit stream to be passed on the cable system?
yes
Does the power indicator light on the TD-754/204 not work?
no
Does the multichannel operator have improper voltage level readings on the TD-754/204?
no
Does the multichannel operator have improper mileage settings on the TD-754/204?
no
Does the multichannel operator have improper alphabet indications on the TD-754/204?
no
Does the multichannel operator obtain improper levels for PCM in/Timing in on the TD-754/204?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be with the system multichannel, TD-754/204 PCM in/Timing in settings.

Actions to Solve TD-754/204 PCM/Timing Problem

1. Check the PCM in/Timing in indication.
2. Check path between the TD-660, KG-27 and TD-754.
3. If there is no PCM/TIM indication on the TD-754 the problem is local and on the transmit side.
4. Check the transmit side of the TD-660, path to the KG-27 through the TD-1065 then the transmit side of the KG-27, path to the TD-754 or transmit side of TD-754.
5. Replace the TD-754/204 at the end having problems.
6. Contact electronic maintenance support for assistance.

Please press the space bar to exit

C.3: Circuit Problems

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
no
Does the problem affect only specific circuits on a system?
yes
Does the multichannel operator have a good circuit path to the distant system end, but the next local operator in the circuit path cannot receive an adequate signal?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a site circuit path.

Actions to Solve Site Circuit Path Problem

1. Ensure 26 pair cable or PCM cable is properly connected to both vans that have the interconnection problem.
2. Have a cable team check for continuity of the cable and wire.
3. Conduct a signal level meter test with the cable from the patch panel or a portable meter.
4. Check cable connectors for damage or moisture
5. Replace the defective cable or wiring if necessary.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)
Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.
Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
no
Does the problem affect only specific circuits on a system?
yes
Does the multichannel operator have a good circuit path to the distant system end, but the next local operator in the circuit path cannot receive an adequate signal?
no
Does the patch panel operator have a good circuit path to the other end, but the switchboard operator cannot receive an adequate signal?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a site patch panel circuit wiring.

1. Check for proper 26 pair cable or wire connections to van.
2. Ensure wire and cable are good by using signal meter test.
3. Ensure proper patch cord connections per circuit routing lists.
4. Check for good patch cords with signal meter.
5. Clean patch cord ends and patch holes with polishing cloth or proper cleaning solution.
6. Replace any defective equipment.
7. Ensure the switchboard is using the correct impedance headset.
8. Contact electronic maintenance support for assistance.
Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
no
Does the problem affect only specific circuits on a system?
yes
Does the multichannel operator have a good circuit path to the distant system end, but the next local operator in the circuit path cannot receive an adequate signal?
no
Does the patch panel operator have a good circuit path to the other end, but the switchboard operator cannot receive an adequate signal?
no
Does the circuit path stop at the multichannel system?
no
Is the switchboard a TTC-41?
yes
Does the problem circuit not have the proper features or is not operating once a circuit path has been established?
no
Do the switchboard circuits not work or sporadic problems are occurring like ghost rings or calls dropping off?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a TTC-41 central processing unit trouble.

Actions to Solve TTC-41 CPU Problem

1. Ensure all function checks can be performed on the CPU.
2. Ensure the proper printouts are obtained when accessing the CPU's RAM.
3. Follow the appropriate troubleshooting guide in the TM.
4. Contact electronic maintenance support for assistance.

Please press the space bar to exit

C.4: Site Installation Guide

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
no
Would you like a printout of the steps to properly install a communications site?
yes

A Multichannel Communications Site Installation Guide

1. SITE ARRIVAL:
   a. Clearance and Reconnaissance.
      (1) Recon and clear site for mines and NBC.
      (2) Post security personnel.
   b. Plan Site area:
      (1) Position vehicles:
         (a) Shelters level.
         (b) Shelters will be placed using minimum cable.
      (2) Position generators:
         (a) Generators level.
         (b) Generators grounded IAW SOP.
         (c) All power cables buried.
         (d) If commercial power is available, check to ensure power is correct and properly grounded.
      (3) Position POL:
         (a) POL placed a minimum of 50 feet from vans and generators.
         (b) No smoking sign posted.
         (c) Fire point set up between vans and generators.
         (d) Fuel containers capped and gaskets in place.
         (e) Fuel can adapters utilized.
         (f) No mogas for stoves. Stove pipes cleaned daily.

2. ANTENNAS:

a. Position antennas so correct azimuth will not cross generators and is clear of obstacles to include other antennas.

Ensure signal paths DO NOT CROSS.

b. Check wattage output at the end of the antenna.

c. Ensure antenna is on correct polarization.

d. Ensure correct elevation/deflection on antenna.

e. Ensure coax has a tight connection and is taped at antenna.

f. Ensure coax has a stress loop.

g. Ensure coax is secure to mast at the top and just above the launcher.

h. Ensure antenna is on proper azimuth.

i. Ensure antenna is guyed IAW TM and SOP.

j. Ensure antenna guy tension is checked twice daily.

k. Ensure coax is secured to van with drip loop and separated from power cable, 26 pair, and PCM cable.

3. PROCEDURE FOR INSTALLING MULTICHANNEL COMMO:

a. Perform preoperational checks on generators IAW TM.

b. Perform preoperational checks on commo equipment IAW TM (Ensure circuit breaker off before power applied to van).

c. Establish commo on engineering frequency (VRC-46 or GRC-106).

d. Perform radio loop test (tropo receiver alignment).

e. Tune radio to assign frequency IAW TM.

f. Establish orderwire communications.

g. Orient antenna for highest receive signal (both azimuth and height).

h. Perform radio to radio system alignment IAW TM.

i. Connect PCM to system and perform orderwire alignment using tone IAW TM.

j. Set CV1548 IAW CRL and TM.

k. Align channels on MUX to hairline using tone.

l. Ensure power cable, 26pr cable, PCM cable and coax do not cross.

m. All back up radio equipment will be aligned to assigned frequency on dummy load.

n. All back up MUX equipment will be secure on current key list and hot.

o. All back up cable will be connected to a hot back up stack.

p. MINIMUM receive sig. for VHF system 20 and UHF 10.

q. MAXIMUM power out for VHF 30 and UHF 20.

r. MAXIMUM Reflective power for VHF 10 and UHF 10.

s. Daily 2404 will be kept in van IAW TM.

t. Did you read Bn. TAC SOP?

A General Site Installation Guide

1. INITIAL PREPARATIONS:
   a. Ensure that all required maps are on hand.
   b. Map reconnaissance of route to site.
   c. Map reconnaissance of site.
   d. Check vehicles; complete, operational.
   e. Check signal equipment; complete, operational.
   f. Check generators; complete, operational.
   g. Check POL (Basic load for initial 72 hours).
   h. Check tents and cots for serviceability.
   i. Check stoves, pipes, for serviceability, and diesel fuel supply.
   j. Check water and rations.
   k. Personal field equipment.(TA-50)
   l. Individual and crew served weapons.
   m. Personal comfort items; first aid kit; toilet paper, etc.
   n. NBC equipment; complete, operational.
   o. TM for van and generator on hand in van.
   p. Check to ensure correct COMSEC material issued.

2. MOVE OUT PREPARATION:
   a. Brief team members:
      (1) Security to include EEFI.
      (2) Correct Site location.
      (3) Route to site, to include checkpoints.
      (4) Duties before, enroute, and upon arrival at site.
      (5) Convoy briefing; speed; anticipated stops, etc.
      (6) Safety briefing.
      (7) Wearing of proper uniform at all times.
   b. Inspect:
      (1) Equipment loaded by loading plan, secure, etc.
      (2) Check vehicles; lights; brakes; etc.

3. RATT/FM:
   a. The following items will be in each RATT/FM rig:
      (1) DD Form 1578 present and filled out properly.
      (2) DA Form 2653-R present and being used.
      (3) Wave propagation charts are present.
      (4) Have a net diagram posted in each van.
      (5) Post all messages from Commanders on the wall.
   b. The items listed below will be done at each RATT/FM site:
      (1) A doublet antenna will be erected on each site within 3 hours after arrival. (RATT ONLY)
      (2) An RC-292 will be installed one hour after arrival on site. (FM ONLY)
      (3) ME-165 being used and a minimum SWR achieved. (RATT ONLY)

(4) The height of the doublet antenna will be in accordance with the wave propagation charts issued by the S-3.

(5) All sub-stations will have their spare RT set.

(6) All FM radios to be checked with a PRM-34.

(7) Remote FM radios to customers.

(8) RC-292s using the correct number of elements for the frequency used.

4. POSITION LIVING AREA.(covered and concealed if possible)

5. POSITION LATRINE. (downhill from living area)

6. SITE DEFENSE: (posted in van)

a. Prepare defensive positions.

b. Position machine guns and grenade launchers at most likely enemy avenues of approach.

c. Ensure each team member has a planned defensive position.

d. Ensure each position has a range card.

7. SITE PLAN: Sr NCOIC/Site Chief is responsible for everything on his site.

a. Each site chief has a drawn site plan consisting of:

(1) Site entrance(s) and exit(s).

(2) Vehicle location (admin vehicle in separate area).

(3) Tent location(s).

(4) Latrine locations.

(5) POL Locations.

(6) Fire point locations.

(7) Helipad location.

(8) Defensive positions.

(9) Site briefing (for visitors).

b. Mission:

(1) Mission (bubble chart, 5x8 card, CRL, and residual chart posted inside van).

(2) Status: systems operational, number of circuits installed and operational.

(3) Maintenance (motor, generator, and CE operator dailies).

(4) Personnel (numbers assigned, on duty, location).

(5) Power source (generator, type/size, or commercial).

(6) Support (POL, BEMS, COMSEC, and/or billets provided by).

(7) Reporting procedures.

8. SITE CLOSE OUT:
   a. Terminate communications, except FM.
   b. Load equipment IAW loading plan.
   c. Recover cable/wire lines.
   d. Load POL.
   e. Police area and fill in latrines.
   f. Brief personnel: driver safety, etc.

Please press the space bar to exit

C.5: Changes Or No Solution

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
yes
Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Has there been a nuclear explosion in the vicinity of the affected site?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
yes
Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
no
Have the multichannel operators been able to get good loopbacks from another location?
yes
Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
no
Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
no

Does the patch panel operator receive a good signal but the switchboard operator does not?
yes
Is the multichannel operator unable to establish a good multichannel system?
yes
Does the multichannel operator get a high reflect power from the antenna system?
no
Does the multichannel operator obtain a low received signal on the receiver or a low power out on the transmitter?
no
Is the multichannel operator unable to get the channels to frame up or the channels are noisy?
no
Does the multichannel operator have timing hits or a rushing noise on the channels and is unable to get a good loopback?
no
Does there appear to be a circuit path problem on the multichannel making it impossible to go beyond the CV-1548?
no
Does the problem affect only specific circuits on a system?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Is the multichannel operator unable to establish a good multichannel system?
no
Does the problem affect only specific circuits on a system?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Does the patch panel operator receive a good signal but the switchboard operator does not?
no
Does the problem affect only specific circuits on a system?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Have the multichannel operators been able to get good loopbacks from another location?
no
Does the problem affect only specific circuits on a system?
no
Has all contact to the communications site been suddenly lost on all systems?
no

Does the problem affect all the channels on a particular system?
no
Does the problem affect only specific circuits on a system?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be an electromagnetic pulse destroyed circuitry.

Actions to Solve EMP Destroyed Equipment

1. Replace damaged power cables and signal cables.
2. Replace damaged antennas.
3. Bring up back-up equipment on-line.
4. Establish communications using RATT rig or AM voice first.
5. Reestablish multichannel communications after coordination with distant sites.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
no
Does the problem affect all the channels on a particular system?
yes
Once the system was properly established, was all contact suddenly lost?
no
Have the multichannel operators been able to get good loopbacks from another location?
yes
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
yes
Does the multichannel operator have a good system but the next operator in the circuit path cannot receive any contact?
no
Does the multichannel operator experience noise on the system that goes away if the frequency is changed?
no
Does the patch panel operator receive a good signal but the switchboard operator does not?
no
Is the multichannel operator unable to establish a good multichannel system?
no
Does the problem affect only specific circuits on a system?
no
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

Your problem may be a system LOS profile.

Actions to Solve System Line of Sight Problem

1. Raise antenna until system residuals are sufficient to install multichannel communications.
2. Relocate system to a higher location if one is available and install a cable system back to the switchboard location.
3. Change the antenna polarization to vertical if it is desired to shoot around an obstacle.
4. If communications cannot be established for the one system then conduct a map reconnaissance to locate a higher site that all multichannel systems can reach.
5. Contact higher level signal planning element for assistance in conducting computer assisted profiling.
6. Relocate communications site to new location and establish communications with all locations.

Please press the space bar to exit

Welcome to Military Communications Troubleshooting Aid(MCTA)

Answer the following questions to determine a probable cause and response for your multichannel communications problem.
Answer questions using lowercase yes or no.
You may also obtain a communications site installation guide by indicating you do not have a problem and want the guide.

Intentional pauses have been inserted in the program for screen readability. To continue press any key.

Do you have a problem you need assistance with somewhere in the Division communications system?
yes
Does the problem affect all the multichannel communications systems on a site?
yes
Once the communications site has been established and confirmed to be operating properly is it still impossible to receive an adequate multichannel signal to all other locations?
no
Has all contact to the communications site been suddenly lost on all systems?
no
Has there been a nuclear explosion in the vicinity of the affected site?
no
Does the problem affect all the channels on a particular system?
no
Does the problem affect only specific circuits on a system?
no
Would you like to make any changes to the answers provided above by starting over and making the correct entry?
no

The answers provided were inconclusive to determine a probable problem. Restart the program if you wish to try again.

Please press the space bar to exit

APPENDIX D: MCTA User's Guide

D.1 Initiating Military Communicaticns Troubleshooting Guide (MCTA)

a. Obtain a copy of the file "MCTA.EXE" which will run on any DOS operating system personal computer.

b. If the "MCTA.EXE" file is not available then obtain a copy of Turbo PROLOG or any other version of PROLOG for a PC. Copy the PROLOG source files from Appendix A into PROLOG and create an executable file. Users instructions for PROLOG are contained in the PROLOG Users Guide. The executable file created with PROLOG will be entitled "MYMCTA.EXE".

c. Get the computer's operating system to a command prompt and type in "MCTA" or "MYMCTA".

d. The program will be initiated and the users instructions will be shown on the screen along with a question asking if you have a problem.

D.2 Operating MCTA

a. The program is constructed using a series of questions to determine what the problem is with the Division Communications System.

b. Answers from the keyboard must be given using a lowercase "yes" or "no" and an enter. If any other response is given the program will ask the question again.

c. Intentional pauses have been inserted in the program for screen readability whenever text exceeds one 25 line screen. To continue once a pause occurs, press any key.

d. You may obtain a site installation guide by indicating you do not have a problem and want the guide.

e. You may make changes to answers provided by saying yes to the make changes question. The program will take out all program cuts preventing backtracking and will proceed to ask questions in a different order than was initially asked. Keep careful track of what questions are answered yes as this will affect the outcome. If unexpected results occur then the program should be reinitiated by starting completely over.

f. Once the program has determined what the probable problem is it will display the problem and provide a possible list of actions to take to solve that problem.

g. After the program has displayed the actions it will tell you to press the space bar to exit. This will return you to the computer's command prompt or to a statement to press any key to return DOSSHELL if MSDOS 5.0 was used and the program was initiated from the menu with a mouse.

D.3 Obtaining a Hardcopy of the Session

a. Once the program has been initiated and the user instructions and first question appear on the screen, then press "Print Screen" to get a copy of the output to that point.

b. If a continuous printout is desired and you are using a dot matrix printer, roll the platen back about 8 spaces so the first question will be above the printhead.

c. Press "Ctrl P" to initiate printing actions on the remainder of the session.

d. Type in the answer to the first question and hit enter. The answer will be printed along with the next question.

e. Printing will continue in this manner until the program is completed or a "Ctrl Break" is initiated.

f. The process must be reinitiated from the start for each session.